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Current Research 2001

Geological Survey of Canada Radiocarbon Dates XXXIII

Collated by R. McNeely

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This date list, GSC XXXIII, is the twenty-second to be published directly by the Geological Survey of Canada. Lists prior to GSC XII were published first in the journal *Radiocarbon* and were reprinted as GSC Papers. The lists through 1967 (GSC VI) were given new pagination, whereas lists VII to XI (1968 to 1971) were reprinted with the same pagination.

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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES XXXIII

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McNeely, R., 2002: Geological Survey of Canada Radiocarbon Dates XXXIII: Geological Survey of Canada, Current Research 2001, 51 p.

Abstract: This list presents 195 radiocarbon age determinations made by the Radiocarbon Dating Laboratory, Geological Survey of Canada, plus 27 AMS dates done by other laboratories (AA, Beta, and TO). The total number (195) of samples from various areas is as follows: Newfoundland (23); Nova Scotia (38); Quebec (50); Ontario (11); Alberta (11); Northwest Territories, mainland (10); Northwest Territories, Arctic Archipelago (12); Nunavut (23); and international (17). Fifteen samples were dated as part of the International Geological Correlation Programme: Project 274 on Coastal Evolution in the Quaternary. Tables 1 and 2 summarize the details of background and standard counts for the 2 L and 5 L counters during the period from January through December 1992.

Résumé : Ce rapport présente les résultats de 195 datations effectuées par le laboratoire de datation au radiocarbone, Commission géologique du Canada, en plus de 27 datations AMS effectuées par d'autres laboratoires (AA, Beta et TO). Les échantillons datés, au nombre de 195, proviennent des régions suivantes : Terre-Neuve (23); Nouvelle-Écosse (38); Québec (50); Ontario (11), Alberta (11); Territoires du Nord-Ouest, continent (10); Territoires du Nord-Ouest, archipel Arctique (12); Nunavut (23); international (17). Quinze échantillons ont été datés dans le cadre du Programme international de corrélation géologique : Projet 274 sur l'évolution côtiere durant le Quaternaire. Les tableaux 1 et 2 résument les valeurs de bruit de fond et d'étalonnage des compteurs de 2 L et 5 L pour la période de janvier à decembre 1992.

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INTRODUCTION

The presentation of dates within each section or subsection of this text is ordered from east to west. All GSC dates, up to and including GSC-5500, are now accessible on a computer database. The 'Date Locator File' provides convenient, fast access to our dates by allowing the user to interactively select indexed parameters, such as laboratory number, submitter, locality, material, age range, to retrieve samples (McNeely, 1988). The date list has been compiled by R. McNeely from descriptions of samples and interpretations of age determinations provided by the collectors and submitters. Supplementary information on this database is available from Mr. P.A. Egginton, Director, Terrain Sciences Division, Geological Survey of Canada, and on the Web at http://sts.gsc.nrcan.gc.ca/radiocarbon/db_e.shtml. Dates for Manitoba and Saskatchewan are available as open files on the Web at http://sts.gsc.nrcan.gc.ca/radiocarbon/pdf_e.shtml.

Sample gas preparation and purification were carried out as described in Lowdon et al. (1977). Carbon dioxide gas proportional counting techniques have been discussed by Dyck (1967). For a review of laboratory operations the reader is referred to Lowdon (1985).

During the period from January through December 1992, both the 2 L counter (Dyck and Fyles, 1963) and the 5 L counter (Dyck et al., 1965) were operated continuously, except in October.

On a monthly basis, the counting rates for backgrounds and standards were within statistical limits. The average background and oxalic acid standard counting rates, and the number of one-day counts used to determine the average, are shown in Tables 1 and 2, respectively.

Age calculations are based on a ^{14}C half-life of 5568 ± 30 years and 0.95 of the activity of the NBS oxalic acid standard. Ages are quoted in radiocarbon years before present (BP), where 'present' is taken to be 1950. The error assigned to each age has been calculated using only the counting errors of sample, background, and standard, and the error in the half-life of ^{14}C (Lowdon and Blake, 1973). Nonfinite dates (i.e. greater than ages) are based on a 4 sigma criterion (99.9% probability), whereas finite dates are based on a 2 sigma criterion (95.5% probability). In addition, all GSC dates are rounded according to the following criteria:

Age (years BP)	Significant figures
0–99	1
100–999	2
1000–9999	3
>10 000	3
nonfinite	2

If $^{13}C/^{12}C$ ratios ($\delta^{13}C$) were available, a 'correction' for isotopic fractionation was applied to the sample age, and the $\delta^{13}C$ value reported. For terrestrial and nonmarine organic materials and terrestrial and marine bones, the ages are conventionally normalized to a $\delta^{13}C$ = -25.0‰ PDB, whereas marine shell ages are also unconventionally corrected to a $\delta^{13}C$ = 0.0‰ PDB; freshwater shell ages are not corrected. All $\delta^{13}C$ determinations were made on aliquots of the sample gas used for age determinations. Since 1989, all $\delta^{13}C$ values have been determined under contract by the OCGS Stable

Table 1. Monthly average count rate for backgrounds and the number of individual counts (N) made during the period January through December 1992.

Month	2 L counter (2 atm) cpm* (N)	5 L counter (1 or 4 atm) cpm* (N)
January	1.261 ± 0.033 (3)	2.231 ± 0.034 (3)
February	1.288 ± 0.028 (3)	2.215 ± 0.033 (3)
March	1.312 ± 0.025 (3)	2.306 ± 0.034 (2)
April	1.238 ± 0.028 (4)	2.234 ± 0.029 (4)
May	1.249 ± 0.025 (2)	2.185 ± 0.041 (2)
June	1.246 ± 0.024 (3)	2.197 ± 0.037 (3)
July	1.209 ± 0.024 (4)	2.106 ± 0.025 (4)
August	1.214 ± 0.025 (3)	2.111 ± 0.026 (4)
September	1.198 ± 0.024 (3)	2.122 ± 0.040 (3)
October	No counts	No counts
November	1.207 ± 0.022 (4)	2.201 ± 0.062 (3)
December	1.200 ± 0.024 (3)	2.193 ± 0.042 (3)

* cpm = counts per minute.

Table 2. Monthly average net count rate for oxalic acid standards (No)** and the number of individual counts (N) made during the period January through December 1992.

Month	2 L counter (2 atm) cpm* (N)	5 L counter (1 or 4 atm) cpm* (N)
January	18.546 ± 0.156 (1)	28.364 ± 0.176 (1)
February	18.276 ± 0.111 (2)	28.129 ± 0.131 (2)
March	18.119 ± 0.128 (2)	28.205 ± 0.135 (2)
April	18.133 ± 0.104 (2)	28.421 ± 0.132 (2)
May	18.139 ± 0.145 (1)	27.969 ± 0.203 (1)
June	18.063 ± 0.123 (1)	28.267 ± 0.155 (1)
July	18.316 ± 0.145 (1)	28.293 ± 0.128 (2)
August	18.357 ± 0.145 (1)	28.013 ± 0.180 (1)
September	18.457 ± 0.104 (2)	28.386 ± 0.132 (2)
October	No counts	No counts
November	18.234 ± 0.101 (2)	28.038 ± 0.135 (2)
December	18.324 ± 0.104 (2)	28.163 ± 0.147 (2)

* cpm = counts per minute.
** No = 95% of the net activity of the NBS Oxalic Acid Standard

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Isotope Facility, Carleton University / University of Ottawa, Ottawa, Ontario. From 1975 to 1989, the $\delta^{13}C$ were determined under contract by R.J. Drimmie of the Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, or by Waterloo Isotope Analysts, Inc., Kitchener, Ontario (R.J. Drimmie, chief analyst) using the same equipment as at the University of Waterloo. Prior to that time some $\delta^{13}C$ determinations were done by the GSC Geochronology Section (R.K. Wanless, Head) and by Teledyne Isotopes, Westwood, New Jersey.

Acknowledgments

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Identification of materials used for dating or associated with the dated material has been carried out by the following specialists:

Arthropods (fossil): J.V. Matthews, Jr.
Macrofossils (plant): J.V. Matthews, Jr., and A. Telka
Mosses: J.A. Janssens
Pollen: R.J. Mott
Wood: R.J. Mott and H. Jetté

The GSC clientele extends their sincere thanks to them.

W. Spirito, L. Brouillette, and J. Cousineau assisted in the development of the 'Date Locator File'. D. Atkinson, A. Ford, P.K. Jorgensen, S. McCuaig, and D. Russell assisted in the preparation of GSC date lists.

EASTERN CANADA

Newfoundland

GSC-5485. Georges Pond

normalized age:	3960 ± 70
$\delta^{13}C$ =	-30.7‰
uncorrected age:	4050 ± 70

The lake sediment, sample GP1-120, was collected by T. Christopher on February 3, 1992, from Georges Pond, Signal Hill, St. John's, Newfoundland (47°34′40″N, 52°41′00″W), at an elevation of 84.8 m and was submitted by P. Davenport.

The sample (24.4 g dry weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treament omitted. The treated sample (17.5 g) yielded 6.11 L of CO_2 gas. The age estimate is based on one count for 2500 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.015 ± 0.073, 1.207 ± 0.022, and 18.234 ± 0.101 cpm, respectively.

Figure 1. *Radiocarbon-dated sites in Newfoundland.*

Comment (P. Davenport): This pond is located on a hill in Signal Hill National Park, on the edge of the urban centre. The dated sediment sample of 3960 ± 70 between 120 and 115 cm depth provides a gross sedimentation rate for the whole core of 0.030 cm/a. This is likely much higher than the natural background sedimentation rate as the upper 55 cm of sediment shows evidence of human disturbance.

Quidi Vidi Lake series

A series of lake sediment samples were taken from Quidi Vidi Lake, St. John's, Newfoundland (47°35′00″N, 52°42′00″W), at a depth of 2.90 m and an elevation of less than 20 m. The samples were collected by T. Christopher on February 7, 1992, and were submitted by P. Davenport. The lake is at the bottom of a large watershed within the city limits. The sediment core was taken to document the effects of urban development upon the sediment and water chemistry of this lake. Pollen analysis was carried out on the whole core (2.0 m). Historical records show that farming began around this lake in AD 1770, and agricultural activities are first recorded at 85 to 80 cm depth in this core.

GSC-5528. Quidi Vidi Lake (I)

normalized age:	1110 ± 70
$\delta^{13}C$ =	-28.7‰
uncorrected age:	1170 ± 70

The lake sediment, sample QV2-105 (27.8 g dry weight), was treated with hot acid and distilled water rinses. The base treatment was omitted (slightly calcareous). The treated sample (22.2 g) yielded 8.26 L of CO_2 gas. The age estimate is based on one count for 2125 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 15.841 ± 0.093, 1.213 ± 0.025, and 18.316 ± 0.104 cpm, respectively.

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Comment (P. Davenport): This sample, from 105 to 100 cm depth, was taken from the same core as GSC-5469. These two samples will provide a more precise pre-European sedimentation rate (i.e. 190 to 105 cm). The date of 1110 ± 70 years indicates a sedimentation rate of 0.21 cm/a between 105 and 85 cm (85 cm is a pollen-dated horizon). The rate of 0.21 cm/a appears to be too great, suggesting that this date is too old.

GSC-5469. Quidi Vidi Lake (II)

normalized age:	2920 ± 60
$\delta^{13}C$ =	-28.0‰
uncorrected age:	2970 ± 60

The basal lake sediment, sample QV2-190 (27.2 g dry weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treament was omitted. The treated sample (21.0 g) yielded 7.19 L of CO_2 gas. The age estimate is based on one count for 2600 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.377 ± 0.110, 2.201 ± 0.062, and 28.038 ± 0.135 cpm, respectively.

Comment (P. Davenport): The radiocarbon date of 2920 ± 60 years at a depth of 190 to 185 cm indicates a natural sedimentation rate of 0.039 cm/a prior to the first farming activities. Sedimentation rates are as high as 0.83 cm/a in the upper core.

Long Pond series

A series of basal lake sediment samples from Long Pond, St. John's, Newfoundland, were collected by T. Christopher and submitted by P. Davenport. This pond, located in a relatively undisturbed area, was chosen as a background pond for comparison with the urban cores in this study (*see* GSC-5528, GSC-5469, and GSC-5485). The sample used for GSC-5480 (47°35′00″N, 52°44′20″W) was collected on March 13, 1992, at an elevation of 43.3 m, whereas the sample used for GSC-5498 (47°18′35″N, 53°45′15″W) was collected on March 7, 1992, at an elevation of 33 m.

GSC-5480. Long Pond (I)

normalized age:	2260 ± 70
$\delta^{13}C$ =	-27.8‰
uncorrected age:	2310 ± 70

The basal lake sediment, sample LP5-115 (25.2 g dry weight), was treated with hot acid (slightly calcareous) and distilled water rinses. The base treatment was omitted. The treated sample (20.4 g) yielded 6.32 L of CO_2 gas. The age estimate is based on two counts for 2100 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.681 ± 0.087, 1.207 ± 0.022, and 18.234 ± 0.101 cpm, respectively.

Comment (P. Davenport): This pond is located within the same watershed as Quidi Vidi Lake, as water from Long Pond flows through the Rennie's River into Quidi Vidi Lake. The pollen analysis that has been carried out on this core indicates that the first farming activity occurred at circa AD 1820 (a depth of 48 cm). The normalized radiocarbon date of 2260 ± 70 years for the sample between 115 to 110 cm indicates a background sedimentation rate of 0.031 cm/a. Upper core rates are as high as 0.71 cm/a.

GSC-5498. Long Pond (II)

normalized age:	5240 ± 90
$\delta^{13}C$ =	-26.3‰
uncorrected age:	5260 ± 90

The lake sediment, sample LPW-135 (29.1 g dry weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (22.4 g) yielded 3.89 L of CO_2 gas. The age estimate is based on two counts for 2090 minutes in the 2 L counter with a mixing ratio of 1.13. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.520 ± 0.083, 1.200 ± 0.024, and 18.324 ± 0.104 cpm, respectively.

Comment (P. Davenport): The radiocarbon date occurs at the base of the core between 135 and 130 cm depth. The normalized age of 5240 ± 90 years indicates an average sedimentation rate of 0.025 cm/a. This likely does not represent the natural sedimentation rate as the upper 28 cm show evidence of human disturbance, which would presumably have increased the sedimentation rate.

Pine Hill Pond series

A complete 380 cm core of postglacial sediment was obtained from Pine Hill Pond, Terra Nova National Park (48°36′N, 53°59′W), adjacent to the Trans-Canada Highway about 6.5 km south of Traytown, Newfoundland. The kettle lake has an area of 2.4 ha and a surface elevation of about 55 m; the core was obtained in a water depth of 1.7 m. Cores from the small steep-sided deep basin of the lake (>5 m) showed evidence of postdepositional deformation. The sedimentary sequence in the core consisted of basal sand (363–380 cm) overlain by silty clay (347–363 cm) and silty gyttja (334–347 cm). A second layer of silty clay (327–334 cm) was overlain by gyttja (0–327 cm) the upper 132 cm of which contained many wood chips. The core was collected with a modified Livingstone corer with a 5 cm diameter coring chamber by J.B. Macpherson and D.L. Butler on June 27, 1991. Samples were submitted by J.B. Macpherson and D.L. Butler.

GSC-5627. Pine Hill Pond (I)

normalized age:	4840 ± 110
$\delta^{13}C$ =	-29.9‰
uncorrected age:	4920 ± 110

The lake sediment, gyttja sample PHP 135-140 cm (54.0 g wet weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (6.2 g) yielded 2.08 L of CO_2 gas. The age estimate is based on two counts for 2120 minutes in the 2 L counter with a mixing ratio of 2.08. The count rates for the

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sample (net) and for monthly backgrounds and standards (net) were 9.937 ± 0.118, 1.191 ± 0.020, and 18.338 ± 0.103 cpm, respectively.

GSC-5307. Pine Hill Pond (II)

normalized age: 8420 ± 170
$\delta^{13}C$ = -28.3‰
uncorrected age: 8470 ± 170

The lake sediment, gyttja sample PHP 252-258 cm (65.0 g wet weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (9.2 g) yielded 2.91 L of CO_2 gas. The age estimate is based on two counts for 1920 minutes in the 2 L counter with a mixing ratio of 1.55. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.462 ± 0.118, 1.261 ± 0.033, and 18.546 ± 0.156 cpm, respectively.

GSC-5625. Pine Hill Pond (III)

normalized age: 8440 ± 120
$\delta^{13}C$ = -27.6‰
uncorrected age: 8490 ± 120

The lake sediment, gyttja sample PHP 260-265 cm (62.0 g wet weight), enclosed in gyttja, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (6.8 g) yielded 2.34 L of CO_2 gas. The age estimate is based on one count for 3755 minutes in the 2 L counter with a mixing ratio of 1.88. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.376 ± 0.075, 1.191 ± 0.020, and 18.338 ± 0.103 cpm, respectively.

GSC-5615. Pine Hill Pond (IV)

normalized age: 9470 ± 200
$\delta^{13}C$ = -24.6‰
uncorrected age: 9470 ± 200

The lake sediment, gyttja sample PHP 290-295 cm (34.7 g wet weight), enclosed in gyttja, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (8.9 g) yielded 2.04 L of CO_2 gas. The age estimate is based on two counts for 2145 minutes in the 2 L counter with a mixing ratio of 2.10. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.643 ± 0.133, 1.191 ± 0.020, and 18.338 ± 0.103 cpm, respectively.

GSC-5334. Pine Hill Pond (V)

normalized age: 11 400 ± 160
$\delta^{13}C$ = -18.9‰
uncorrected age: 11 300 ± 160

The lake sediment, basal gyttja sample PHP 320-327 cm (94.2 g wet weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (18.4 g) yielded 2.40 L of CO_2 gas. The age estimate is based on one count for 3970 minutes in the 2 L counter with a mixing ratio of 1.85. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.489 ± 0.077, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

GSC-5335. Pine Hill Pond (VI)

normalized age: 12 400 ± 150
$\delta^{13}C$ = -19.9‰
uncorrected age: 12 400 ± 150

The basal lake sediment, sample PHP 336-339 cm (149.0 g wet weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (76.4 g) yielded 3.18 L of CO_2 gas. The age estimate is based on one count for 3900 minutes in the 2 L counter with a mixing ratio of 1.41. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.924 ± 0.060, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

Comment (J.B. Macpherson): The basal date of 12 400 ± 150 BP (GSC-5335) was obtained from the basal silty gyttja between two layers of silty clay. The overlying silty clay is interpreted from loss-on-ignition, pollen, and diatom data as representing a climatic reversal, presumably the Younger Dryas event as there is no evidence higher in the core of a later cold episode (Wolfe and Butler, 1994). Dates on pre-Younger Dryas lake sediment in Newfoundland are generally younger than GSC-5335 (Anderson and Macpherson, 1994), although corresponding sediment is dated 13 200 ± 300 BP (GSC-3608) at Leading Tickles on the northeast coast (Blake, 1983; Macpherson and Anderson, 1985).

The date of 11 400 ± 160 BP (GSC-5334) was obtained from the base of the gyttja and is interpreted from loss-on-ignition, pollen, and diatom evidence indicating climatic amelioration as dating the beginning of the Holocene (Wolfe and Butler, 1994); this date is older than other dates representing the same event in Newfoundland (Anderson and Macpherson, 1994). Abnormally high values for $\delta^{13}C$ for both GSC-5334 and GSC-5335 indicate probable incorporation of old carbon by aquatic photosynthesis and the probability that both dates are too old.

GSC-5615 (9470 ± 200 BP) dates the initial increase of *Picea* and is in agreement with dates on this horizon from other sites in central Newfoundland (Leading Tickles: 9600 ± 230 BP (GSC-4183); Millertown: 9340 ± 140 BP (GSC-4231); Small Scrape Pond: 9470 ± 160 BP (GSC-3937)) (Blake, 1986; McNeely and McCuaig, 1991; Macpherson, 1995).

GSC-5625 (8440 ± 120 BP) and GSC-5307 (8420 ± 120 BP) date the initial expansion of *Pinus*, dated elsewhere in central Newfoundland at 6340 ± 70 BP (GSC-4148; Bishop's Falls)

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and 5960 ± 120 BP (GSC-4086; Leading Tickles; McNeely and McCuaig, 1991; Macpherson, 1995). GSC-5625 confirms the early date of 8.4 ka BP indicated by GSC-5307 for the *Pinus* expansion at Pine Hill Pond. As there is no reason to suspect that either date is too old this is the earliest Holocene expansion of pine on the Island of Newfoundland.

The date of 4840 ± 110 (GSC-5627) immediately precedes the appearance of wood chips in the sediment, interpreted as indicating the work of beavers. Subsequent minor changes in pollen spectra (increases in *Alnus*, *Cyperaceae*, some herbs and aquatics including *Pediastrum*) are attributable to the same cause. The date suggests a fairly uniform rate of Holocene sediment accumulation and negates an alternative origin for the wood chips in early twentieth-century logging.

GSC-5253. St. Anthony

normalized age:	6750 ± 100
$\delta^{13}C$ =	-26.7‰
uncorrected age:	6770 ± 100

The lake sediment, basal detrital peat, was enclosed in dark grey silty clay below with dark brown gyttja above. Sample AP-85-3 (350–360 cm) was collected by T.W. Anderson on July 6, 1985, at an elevation of 84 m from, 4.5 km southwest of St. Anthony, on the east side of Highway 73, Newfoundland (51°20′48″N, 55°38′30″W). The sample was submitted by T.W. Anderson.

The sample (123.2 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (25.5 g) yielded 6.18 L of CO_2 gas. The age estimate is based on two counts for 2550 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.908 ± 0.064, 1.213 ± 0.021, and 18.379 ± 0.137 cpm, respectively.

GSC-5241. Tom Roses Pond

normalized age:	8730 ± 80
$\delta^{13}C$ =	-26.3‰
uncorrected age:	8750 ± 80

GSC-5241. 2nd count

normalized age:	8750 ± 80
$\delta^{13}C$ =	-26.3‰
uncorrected age:	8770 ± 80

The basal peat was underlain by dark grey sand and stoney clay and overlain by peat. Sample AP-85-10 (200 cm) was collected by T.W. Anderson on July 15, 1985, from east of Tom Roses Pond, 13 km southeast of Main Brook, Newfoundland (51°05′20″N, 55°54′50″W), at an elevation of about 75 m. The sample was submitted by T.W. Anderson.

The sample (100.3 g wet weight) was treated with cold base, hot acid (noncalcareous) and distilled water rinses. The treated sample (25.4 g) yielded 6.6 L of CO_2 gas. The age estimate is based on one count for 3900 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.533 ± 0.061, 2.055 ± 0.028, and 28.334 ± 0.123 cpm, respectively.

Second count: The age estimate is based on one count for 3900 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.492 ± 0.066, 2.196 ± 0.038, and 28.279 ± 0.131 cpm, respectively.

GSC-5206. Hermitage

normalized age:	10 600 ± 140
$\delta^{13}C$ =	-19.1‰
uncorrected age:	10 500 ± 140

The lake sediment, basal gyttja sample AP-82-4A, was collected by T.W. Anderson on August 29, 1982, from about 1.5 km south of the town of Hermitage, on the south coast of Newfoundland (47°32′45″N, 56°55′30″W), at an elevation of 3.5 m. The sample was submitted by T.W. Anderson.

The sample (32.6 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (24.5 g) yielded 3.80 L of CO_2 gas. The age estimate is based on one count for 2515 minutes in the 2 L counter with a mixing ratio of 1.17. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.965 ± 0.062, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

GSC-5302. South Brook Valley

normalized age:	13 100 ± 220
$\delta^{13}C$ =	-26.3‰
uncorrected age:	13 200 ± 220

The basal gyttja was underlain by grey sandy clay and overlain by banded detrital gyttja. Sample AP-86-4 (261.5–268 cm) was collected by T.W. Anderson on August 11, 1986, from South Brook Valley, 11.5 km south of Pasadena, Newfoundland (48°54′48″N, 57°37′37″W), at an elevation of 111 m. The sample was submitted by T.W. Anderson.

The sample (245.8 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (91.5 g) yielded 5.49 L of CO_2 gas. The age estimate is based on two counts for 2100 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.571 ± 0.089, 1.188 ± 0.059, and 18.396 ± 0.155 cpm, respectively.

Highway 480 series

A series of lake-sediment samples from a pond alongside Highway 480, about 7 km north of Burgeo, Newfoundland (47°40′45″N, 57°37′40″W), at an elevation of 165 m were collected by T.W. Anderson on August 1, 1989, and were submitted by T.W. Anderson.

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GSC-5315. Highway 480 (I)

normalized age: 8460 ± 120
$\delta^{13}C$ = -26.1‰
uncorrected age: 8480 ± 120

The lake sediment, sample AP-89-2D (87–93 cm; 80.6 g wet weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (15.8 g) yielded 3.82 L of CO_2 gas. The age estimate is based on two counts for 2070 minutes in the 2 L counter with a mixing ratio of 1.18. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.360 ± 0.075, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

GSC-5309. Highway 480 (II)

normalized age: 9720 ± 110
$\delta^{13}C$ = -23.4‰
uncorrected age: 9690 ± 110

The lake sediment, sample AP-89-2C (120–122.5 cm; 87.4 g wet weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (19.9 g) yielded 3.69 L of CO_2 gas. The age estimate is based on one count for 3770 minutes in the 2 L counter with a mixing ratio of 1.21. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.469 ± 0.058, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

GSC-5281. Highway 480 (III)

normalized age: 11 900 ± 140
$\delta^{13}C$ = -25.9‰
uncorrected age: 11 900 ± 140

The lake sediment, sample AP-89-2B (167–170 cm; 262.6 g wet weight), enclosed in sandy clay, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (89.7 g) yielded 3.16 L of CO_2 gas. The age estimate is based on one count for 3730 minutes in the 2 L counter with a mixing ratio of 1.44. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.095 ± 0.060, 1.216 ± 0.026, and 18.122 ± 0.101 cpm, respectively.

GSC-5268. Burgeo

normalized age: 9630 ± 150
$\delta^{13}C$ = -25.6‰
uncorrected age: 9640 ± 150

The lake sediment, basal gyttja, was underlain by noncalcareous blue-grey silty clay and overlain by gyttja. Sample AP-89-1 (635–643 cm) was collected by T.W. Anderson on July 30, 1989, from 1500 m north of Burgeo, 250 m off the left side of Highway 480 in the widest part of Aaron Arm, Newfoundland (47°37′11″N, 57°38′23″W), at an elevation of 15.6 m. The sample was submitted by T.W. Anderson.

The sample (133.0 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (21.5 g) yielded 5.27 L of CO_2 gas. The age estimate is based on two counts for 2565 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.684 ± 0.058, 1.224 ± 0.025, and 18.875 ± 0.273 cpm, respectively.

GSC-5272. 'Buck Pond'

normalized age: 10 400 ± 180
$\delta^{13}C$ = -18.4‰
uncorrected age: 10 300 ± 180

The lake sediment, basal gyttja sample AP-89-7 (428–436 cm), was collected by T.W. Anderson on August 11, 1989, from Buck Pond (unofficial name), 55 km north of Burgeo, Newfoundland (48°01′10″N, 57°39′40″W), at an elevation of about 391 m. The sample was submitted by T.W. Anderson.

The sample (140.3 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (50.5 g) yielded 2.29 L of CO_2 gas. The age estimate is based on one count for 3400 minutes in the 2 L counter with a mixing ratio of 1.94. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.260 ± 0.082, 1.224 ± 0.025, and 18.875 ± 0.273 cpm, respectively.

GSC-5257. Stephenville

normalized age: 11 300 ± 160
$\delta^{13}C$ = -16.4‰
uncorrected age: 11 200 ± 160

The basal gyttja was underlain by grey and buff banded silty clay and overlain by reddish-brown gyttja. Sample AP-89-5 (308–311 cm) was collected by T.W. Anderson on August 5, 1989, from 95 km east of Stephenville, on the south side of Highway 480, Newfoundland (48°23′27″N, 57°42′16″W), at an elevation of 287 m. The sample was submitted by T.W. Anderson.

The sample (144.6 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (28.1 g) yielded 4.12 L of CO_2 gas. The age estimate is based on two counts for 2420 minutes in the 2 L counter with a mixing ratio of 1.09. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.704 ± 0.059, 1.224 ± 0.025, and 18.875 ± 0.273 cpm, respectively.

GSC-5300. Humber River gorge

normalized age: 12 700 ± 110
corrected age: 12 300 ± 110
$\delta^{13}C$ = +1.2‰
uncorrected age: 12 300 ± 110

The marine shells (*Balanus hameri*, identified by J. Maunder) were enclosed in clayey silt. Sample 914079 was collected by M. Batterson on June 23, 1991, from on the south side of the Trans Canada Highway, within the Humber River gorge, about 4.5 km east of Corner Brook, Newfoundland (48°56.9′N, 57°50.8″W), at an elevation of 13 m. The sample was submitted by M. Batterson.

The sample (45.6 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (36.6 g) yielded 7.89 L of CO_2 gas. The age estimate is based on one count for 3710 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.164 ± 0.061, 2.287 ± 0.039, and 28.354 ± 0.135 cpm, respectively.

GSC-5267. Rose Blanche

normalized age: 10 800 ± 170
$\delta^{13}C$ = -25.6‰
uncorrected age: 10 800 ± 170

The basal gyttja was underlain by banded grey/black silty fine sandy clay and overlain by dark brown-black gyttja. Sample AP-89-11 (280.5–286 cm) was collected by T.W. Anderson on August 15, 1989, from 8 km west of Rose Blanche, on the north side of Highway 84, southwestern Newfoundland (47°36′41″N, 58°44′40″W), at an elevation of 2.5 m. The sample was submitted by T.W. Anderson.

The sample (143.4 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (14.8 g) yielded 3.02 L of CO_2 gas. The age estimate is based on one count for 3775 minutes in the 2 L counter with a mixing ratio of 1.47. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.897 ± 0.063, 1.224 ± 0.025, and 18.875 ± 0.273 cpm, respectively.

Nova Scotia

GSC-5389. Aspy Bay

normalized age: 150 ± 70
$\delta^{13}C$ = -27.2‰
uncorrected age: 190 ± 70

The basal peat, sample 91-300-001-35-38, was collected by R.B. Taylor on October 26, 1991, from a brackish marsh about 150 m landward of coastal dune ridges on the submerged back barrier ridges of South Harbour Beach, at the head of Aspy Bay, Cape Breton Island, Nova Scotia (46°52.9′N, 60°26.15′W), at a depth of 2 m. The sample was submitted by J. Shaw.

Figure 2. *Radiocarbon-dated sites in Nova Scotia.*

The sample (33.9 g wet weight) was treated with cold base, hot acid, and distilled water (noncalcareous). The treated sample (6.1 g) yielded 5.06 L of CO_2 gas. The age estimate is based on two counts for 2035 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.643 ± 0.100, 1.246 ± 0.024, and 18.063 ± 0.123 cpm, respectively.

Comment (R.B. Taylor and J. Shaw): The purpose of this sample was to date the prograded beach-ridge complex at Aspy Bay. It is one of a series of radiocarbon dates on samples from organic deposits overlying coastal beach-ridge complexes in Atlantic Canada. The sample site is a brackish marsh about 150 m landward of coastal dune ridges that rise to almost 4 m above mean sea level. The sample was the lowest 3 cm of a 38 cm thick layer of freshwater peat that overlies sandy beach ridges. Given the thickness of the peat, we suspect that the prograded beach-ridge complex at Aspy Bay is considerably older than this date suggests; there is a strong possibility that the sample was contaminated by modern rootlets.

TO-3627. Amaguadees site

normalized age: 12 190 ± 80

The wood twigs (*Salix*, identified by R.J. Mott) were enclosed in laminated organic silt (sandy peat). Sample 82-MS-31 (twigs – 4 cm of block 6) was collected by R.J. Mott on July 1, 1982, from the Amaguadees site, about 7 km southwest of Eskasoni, East Bay, Bras d'Or Lake, Cape Breton Island, Nova Scotia (45°54′45″N, 60°40′20″W), at an elevation of about 7 m; it was submitted by R.J. Mott. The age is normalized to a $\delta^{13}C$ of -25‰.

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Comment (R.J. Mott): Four bulk sediment samples from this site were dated previously and reported in McNeely and Jorgensen (1992). This AMS date of 12.2 ka BP was on small twigs of willow (*Salix*) from an interval in laminated silt with organic material immediately below a thin peat layer that was dated at 12.6 ka BP (GSC-4062). This indicates that the bulk sample date is only 400 to 500 years older than the AMS date, which corroborates the interpretation that deglaciation was relatively early in this area of Cape Breton Island. Although the landscape was available early for colonization by plants, only shrub and herb tundra communities developed during the warm period following deglaciation (Allerød) and trees had not invaded the area before the climate cooled again during the Younger Dryas interval (Mott and Stea, 1993).

Cormier Lake series

Cormier Lake is a small lake, possibly a kettle, in the lowland area along the west coast bordering the Cape Breton Highlands, about 5.5 km northeast of Belle Côte, Cape Breton Island, Nova Scotia (46°29′24″N, 61°04′00″W), at an elevation of about 57 m. Cores were obtained on July 8, 1990, in the central part of the lake with a modified Livingstone sampler in about 1 m of water. Cores penetrated to a depth of 604 cm below the mud-water interface. Brown detrital gyttja to a depth of 580 cm overlies 8 cm of organic silt and grey silty clay to 604 cm, below which the corer would not penetrate. GSC-5643 was submitted by H. Jetté; all other samples were submitted by R.J. Mott.

GSC-5643. Cormier Lake (I)

normalized age: 3950 ± 100
$\delta^{13}C$ = -18.6‰
uncorrected age: 3850 ± 100

The lake sediment, gyttja, sample 90-MS-08 (338–342 cm; 43.5 g wet weight), enclosed in gyttja, was treated with hot acid and distilled water rinses. The base treatment was omitted (noncalcareous). The treated sample (3.7 g) yielded 2.01 L of CO_2 gas. The age estimate is based on two counts for 2160 minutes in the 2 L counter with a mixing ratio of 2.17. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.282 ± 0.127, 1.284 ± 0.021, and 18.219 ± 0.103 cpm, respectively.

GSC-5275. Cormier Lake (II)

normalized age: 10 700 ± 170
$\delta^{13}C$ = -23.5‰
uncorrected age: 10 700 ± 170

The lake sediment, basal gyttja, sample 90-MS-08 (584–586 cm; 57.8 g wet weight), enclosed in gyttja and clay, was treated with hot acid and distilled water rinses. The base treatment was omitted (noncalcareous). The treated sample (18.9 g) yielded 2.91 L of CO_2 gas. The age estimate is based on one count for 3120 minutes in the 2 L counter with a mixing ratio of 1.55. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.977 ± 0.070, 1.224 ± 0.025, and 18.875 ± 0.273 cpm, respectively.

Beta-61401. CAMS-5810. Cormier Lake (III)

normalized age: 9970 ± 80

The wood, a small twig, sample 90-MS-08 (595–600 cm; 0.06 g wet weight; not identifiable according to R.J. Mott), enclosed in silty clay, was treated with acid and alkali prior to gas preparation. The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (R.J. Mott): The AMS date (Beta-61401) on a small twig, probably willow (*Salix* sp.), from the sediment interval about 10 cm below that used for the conventional date (GSC-5275) indicates that the latter date is anomalous. Hardwater error is probably the cause. The sediment stratigraphy and the age of the basal organic sediments show that organic accumulation began at this location at the beginning of the Holocene, and the late-glacial climatic oscillation correlative to the Allerød/Younger Dryas that is recorded in many lake sequences in the Maritimes is not present here. The implication is that glacial ice may have covered the site until about 10 ka as a residual mass from previous widespread glaciation or a renewal of glaciation during the Younger Dryas cold interval (Stea and Mott, 1989).

West Mabou Harbour site

The West Mabou Harbour site was exposed in a coastal cliff along the Northumberland Strait south of the entrance to Mabou Inlet. The site was originally sampled by Gilles St. Jean during a mapping project of the area and was re-sampled by R.J. Mott and others for pollen analysis and radiocarbon dating. The site showed about 65 cm of organic-bearing sediments overlying 10 cm of weathered sand, with a poorly developed soil profile, over the basal diamicton (till) of the area. Overlying the organic zone, about 1 m of banded red and grey clay separated this zone and the upper, surficial brownish-red diamicton. Within the organic zone, a basal 10 cm thick layer of matted peat with twigs is overlain by thinner peaty layers and stringers of fine organic sediment separated by thin layers and wedges of red-brown diamicton and sand silty clay. The organic seams thin upward.

GSC-5427. West Mabou Harbour

normalized age: 10 900 ± 100
$\delta^{13}C$ = -26.2‰
uncorrected age: 10 900 ± 100

The woody, fibrous peat was overlying sand and diamicton. Sample '84-MS-12 (base)' was collected by R.J. Mott, H. Jetté, and J. Dale on June 18, 1984, from the Mabou Harbour site (Hogs Back site of G. St. Jean), along the coast at West Mabou Harbour, Cape Breton Island, Nova Scotia (46°04′40″N, 61°28′00″W), at an elevation of 12 m; it was submitted by R.J. Mott.

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The sample (134.40 g wet weight) was treated with cold base, hot acid, and distilled water rinses (noncalcareous). The treated sample (10.7 g) yielded 8.8 L of CO_2 gas. The age estimate is based on one count for 3800 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.177 ± 0.056, 2.111 ± 0.026, and 28.013 ± 0.180 cpm, respectively.

Comment (R.J. Mott): The 10.9 ka date on the bulk sample of the basal peat layer places deposition of the peat at the end of the late-glacial warm interval that followed deglaciation and the onset of cooler conditions during the Younger Dryas (Mott et al., 1986). During the Younger Dryas cool event, solifluction and mass wasting occurred and local glaciers may have been reactivated or regenerated (Stea and Mott, 1989), which could account for the increased mineral sediment deposition upward in the sequence. Preliminary pollen analysis shows that herbs and shrubs dominated the landscape and trees had not yet invaded the area as is seen in other sites in Cape Breton Island (Mott and Stea, 1993).

Judique site

The site was discovered by R. Turner of Maritime Groundwater Ltd. while trenching for a remediation study of a gasoline leak at a nearby service station. R.R. Stea of the Nova Scotia Department of Natural Resources subsequently sampled the site. The excavation was done on a flat terrace of a possible former lake plain and showed about 1 m of brown sandy stoney fill over over about 1 m of red-brown silty sandy clay with some pebbles over about 1.5 m of brown clay. Below this was an 8 to 10 cm thick fibrous peat layer and brown clay to a further 1.5 m depth. A bulk peat sample was used for dating.

GSC-5607. Judique

normalized age:	11 300 ± 110
$\delta^{13}C$ =	-27.9‰
uncorrected age:	11 300 ± 110

The fibrous peat was underlain by clay. Sample 'PL-92-147 (Stea)' was collected by R.R. Stea on September 15, 1992, from the Judique site, at A and D Ultramar gasoline station in Judique, Cape Breton Island, Nova Scotia (45°52.4′N, 61°29.4′W), at an elevation of about 8 m; it was submitted by R.R. Stea and R.J. Mott.

The sample (144.5 g wet weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (12.1 g) yielded 7.85 L of CO_2 gas. The age estimate is based on one count for 2390 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.866 ± 0.067, 2.193 ± 0.027, and 28.110 ± 0.129 cpm, respectively.

Comment (R.J. Mott and R.R. Stea): The age of 11.3 ka BP confirms that the peat layer represents the pre-Younger Dryas warm interstadial interval that followed deglaciation (Mott et al., 1986). The age and stratigraphy of the site are similar to those of many other sites in the Maritimes where organic sediments that accumulated during the warm interstadial were subsequently buried by mineral sediments of the Younger Dryas cool event (Stea and Mott, 1989). Preliminary pollen analysis showed that sedges, herbs, and shrubs characterized the area and trees had not invaded the area as is seen at several other sites in Cape Breton Island (Mott and Stea, 1993).

'Noname Lake' series

Noname Lake (unofficial name) is a small unnamed lake at the headwater of the Salmon River, about 3.2 km west of Ogden and about 15 km west-southwest of Guysborough, Nova Scotia (45°21.22′N, 61°40.56′W), at an elevation of about 70 m, with a maximum water depth of 7 m. A core, collected by H. Jetté on July 25, 1989, totalling 601 cm below the mud-water interface was taken in the deepest part of the lake with a modified Livingstone corer. The coring penetrated dark yellowish-brown gyttja to about 350 cm where clay and silt content increases steadily to 418 cm depth. A transition to soft, massive, purplish-grey clay is marked below 418 cm by a zone of black granules. The clay becomes firmer and coarsely banded with depth and then distinctly laminated below 485 cm. Between about 532 and 542 cm, the clay is banded and is more organic with seams of black organic clay, small twigs and other organic fragments. The sediment beneath is massive purplish-grey clay with some peds of stiff clay to 580 cm where it becomes stiff, laminated, grey clay to the base of the core. The samples were submitted by R.J. Mott.

GSC-5432. 'Noname Lake' (I)

normalized age:	10 200 ± 140
$\delta^{13}C$ =	-28.5‰
uncorrected age:	10 200 ± 140

The lake sediment, gyttja, sample 89-MS-19 (416–418 cm; 106.5 g wet weight), enclosed in clay and gyttja, was treated with hot acid and distilled water rinses. The base treatment was omitted (noncalcareous). The treated sample (29.9 g) yielded 3.39 L of CO_2 gas. The age estimate is based on one count for 2000 minutes in the 2 L counter with a mixing ratio of 1.30. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.132 ± 0.073, 1.209 ± 0.024, and 18.316 ± 0.145 cpm, respectively.

Beta-62944. 'Noname Lake' (II)

normalized age:	10 940 ± 80

The small wood twigs, sample 89-MS-19 (532 cm; probably willow, *Salix*), were enclosed in banded clay and clayey gyttja. The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (R.J. Mott): The date of 10.2 ka BP for the contact between the upper organic material and the underlying mineral sediments is a reliable age for the beginning of the Holocene organic sequence. The organic horizon within the underlying clayey sediments dated by a twig with an AMS

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date of 10.9 ka BP, represents either organic material redeposited in the lake during the Younger Dryas cold interval, or the warm interval preceding the Younger Dryas. If the latter explanation is valid, then the time between deglaciation of the site and onset of the Younger Dryas cold interval was relatively short. This contrasts with many other sites that show a much longer pre-Younger Dryas warm interval (Mott et al., 1986; Stea and Mott, 1989), suggesting that ice remained relatively late in this area and may have provided a remnant for reactivation during the Younger Dryas.

Cumminger Lake

Cumminger Lake is a large lake in a broad valley leading from the highlands in the north. The coring penetrated to a depth of 631 cm below the mud-water interface. The core shows soft grey gyttja becoming clayey to a depth of about 410 cm, where it becomes more silty. A black organic clay zone 2 cm thick marks the contact with soft grey clay at 496 cm. At 505 cm, the grey clay is stiffer and extends to 566 cm. From 566 to 588 cm the sediment is a more organic grey clayey gyttja overlying banded grey clay to 611 cm. Below 611 cm to the core base at 631 cm the clay is sticky with some gravel content.

GSC-5250. Cumminger Lake

normalized age:	11 000 ± 190
$\delta^{13}C$ =	-23.5‰
uncorrected age	11 000 ± 190

The lake sediment, clayey gyttja, had algal, clayey, and silty gyttja above and clay below. Sample 90-MS-10 (493–496 cm) was collected by R.J. Mott on July 11, 1990, from Cumminger Lake about 4 km south of the junction of highways 7 and 347, in Guysborough County, Nova Scotia (45°16′03″N, 62°02′40″W), at an elevation of 30 m; it was submitted by R.J. Mott.

The sample was treated with hot acid and distilled water rinses. The base treatment was omitted (noncalcareous). The treated sample (40.7 g) yielded 2.03 L of CO_2 gas. The age estimate is based on two counts for 2180 minutes in the 2 L counter with a mixing ratio of 2.19. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.682 ± 0.098, 1.213 ± 0.021, and 18.379 ± 0.137 cpm, respectively.

Comment (R.J. Mott): This site appears to have a basal lithological sequence similar to, although not as prominent as, that of many other sites in the Maritimes that record a late-glacial climatic oscillation that is correlated with the Allerød/Younger Dryas oscillation (Mott et al., 1986; Stea and Mott, 1989). The date (GSC-5250) of 11.0 ka BP appears to be at the base of the Holocene organic sequence, which should date about 10 ka. Therefore, the date is considered to be anomalously old by about 1000 years.

Indian Lake series

Indian Lake is on the Antigonish Highlands, about 20 km southwest of Antigonish, Nova Scotia (45°30.9′N, 62°12.0′W), an area of presumably remnant or renewed late-glacial ice. The core was collected by R.J. Mott, M. Frappier, and R. Stea on July 31, 1981, at an elevation of 225 m, in the centre of the north end of the lake in 1.75 to 2 m of water. A core totalling 713 cm in length was recovered from the lake. Sand at the base of the core is overlain at 700 cm depth below the mud-water interface by stiff banded grey silt and clayey silt to 678 cm. Faintly banded silty gyttja to 660 cm overlies the basal sediments and is overlain by faintly banded grey clay to 649 cm. An overlying transition zone of yellowish-grey banded organic silt to 645 cm grades into banded silty gyttja, which in turn grades into greyish-brown slightly silty gyttja and dark brown algal gyttja to the surface. Sample Beta-66121 was submitted by H. Jetté; all other samples were submitted by R.J. Mott.

Beta-66121. Indian Lake (I)

normalized age:	5690 ± 150

The lake sediment, gyttja, sample 91-MS-07 (458–462 cm), was enclosed in gyttja. The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-5347. Indian Lake (II)

normalized age:	9850 ± 130
$\delta^{13}C$ =	-23.6‰
uncorrected age:	9830 ± 130

The lake sediment, gyttja, sample 91-MS-07 (643–645 cm; 51.6 g wet weight), enclosed in gyttja and organic clay, was treated with hot acid and distilled water rinses. The base treatment was omitted (noncalcareous). The treated sample (6.6 g) yielded 2.54 L of CO_2 gas. The age estimate is based on one count for 3910 minutes in the 2 L counter with a mixing ratio of 1.74. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.333 ± 0.076, 1.238 ± 0.028, and 18.133 ± 0.104 cpm, respectively.

GSC-5293. Indian Lake (III)

normalized age:	11 600 ± 170
$\delta^{13}C$ =	-20.9‰
uncorrected age:	11 500 ± 170

The organic lake sediment, sample 91-MS-07 (660–663 cm; 79.8 g wet weight), enclosed in clay and organic clay, was treated with hot acid and distilled water rinses. The base treatment was omitted (noncalcareous). The treated sample (25.7 g) yielded 2.17 L of CO_2 gas. The age estimate is based on one count for 3950 minutes in the 2 L counter with a mixing ratio of 2.01. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.330 ± 0.078, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

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Beta-62945. Indian Lake (IV)

normalized age: 11 020 ± 85

The small woody twigs, sample 91-MS-07 (668–671 cm; probably *Salix*), were enclosed in silty clay gyttja. The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (R.J. Mott): The date of 11.0 ka (Beta-62945) on twigs (probably willow) near the base of the lower organic zone shows that the bulk sediment date of 11.6 ka (GSC-5293) at the top of the zone is anomalously old by several hundred years. The AMS date also indicates that the area was deglaciated and organic sediments had begun to accumulate just before the onset of the Younger Dryas cold interval, represented by the overlying minerogenic zone. The date of 9.9 ka (GSC-5347) at the base of the upper organic zone helps bracket the cold interval between 10 and 11 ka as seen in many sites throughout the Maritimes (Mott et al., 1986; Stea and Mott, 1989). The mid-Holocene age of 5.7 ka (Beta-66121) dates the pollen assemblages at this level in the profile (Jetté and Mott, 1995).

Beta-66127. Chance Harbour Lake

normalized age: 6540 ± 120

The lake sediment was enclosed in black gyttja. The black gyttja, sample MS-85-16 (509-510 cm), was collected by H. Jetté on August 13, 1985, from Chance Harbour Lake, about 6.5 km north-northeast of Trenton, Nova Scotia (45°40.2′N, 62°36.7′W), at an elevation of about 12 m; it was submitted by H. Jetté. The age is normalized to a $\delta^{13}C$ of -25‰.

Comments (R.J. Mott): Seven samples from this site were dated previously and reported in McNeely and McCuaig (1991) and in a publication on the palynology of the site (Jetté and Mott, 1989). This increment was dated to verify the increment of the core related to 6 ka. Pollen results from the interval adjacent to this age were used in the report on the paleoecology of Canada at 6 ka (Jetté, 1995).

Truro series

A late-glacial buried organic deposit was exposed in a roadcut during widening of Highway 102, 300 m north of the Onslow Bridge over the Salmon River at Truro, Nova Scotia (45°22′05″N, 63°19′03″W), at an elevation of 4 to 5 m above the high tide level (Stea and Mott, 1989). The section showed organic sediment up to 50 cm thick that becomes sandy with thinning organic horizons in the top 20 cm. This was overlain by 1 to 2 m of reddish-brown diamicton with a few boulders. The organic sediment rested on about 5 to 10 cm of buff or grey silty clay and reddish sand with pebbles, and this was underlain by reddish stony diamicton. Samples were collected by R.J. Mott and R.R. Stea on August 13, 1985, and submitted by R.J. Mott. GSC-4265 (11 400 ± 150) and GSC-4297 (12 000 ± 120) were reported previously in McNeely and McCuaig (1991).

TO-3629. Truro (I)

normalized age: 7670 ± 60

The wood twigs, sample MS-85-18 (base of monolith; *Salix*, identified by R.J. Mott), were enclosed in silty peat. The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-4265. Truro (II)

uncorrected age: 11 400 ± 150

The sandy peat, sample MS-85-18 'Top 1.5 cm' (109.3 g wet weight), was overlain by red sand and diamicton, and underlain by peat. The sample was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The age estimate is based on one count for 4200 minutes (one 3-day) in the 5 L counter with a mixing ratio of 1.00.

TO-3880. Truro (III)

normalized age: 11 440 ± 80

The unidentified wood twigs, sample MS-85-18 (base of peat; 76 mg dry weight), were enclosed in silty peat. The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-4297. Truro (IV)

uncorrected age: 12 000 ± 120

The basal sandy and silty peat, sample MS-85-18 'Basal 1 cm' (106.7 g wet weight), was overlain by peat and underlain by sand. The sample was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The age estimate is based on three counts for 4140 minutes (three 1-day) in the 2 L counter with a mixing ratio of 1.00.

Comment (R.J. Mott): As mentioned in McNeely and McCuaig (1991), the organic horizon represents a warming interval following deglaciation when shrub and herb taxa indicative of tundra-like conditions with spruce beginning to invade characterized the area (Stea and Mott, 1989). Reversion of the climate after about 11 ka is seen in evidence from numerous sites in the region and is related to the Younger Dryas cooling event (Mott et al., 1986). Vegetation was strongly affected and solifluction and mass wasting increased, and renewed or reactivated glaciation occurred in some areas. The diamicton overlying the organic sediment suggests possible glaciation of the site (Stea and Mott, 1989).

The AMS date TO-3629 (7670 ± 60 years BP) was obtained on organic matter washed from the silty clay and sand layer immediately below the compact sandy peat of the organic bed. This age is much too young for the interval involved and is considered anomalous, possibly contaminated by younger rootlets.

Twigs from a 1 cm interval above the basal 1 cm of sandy peat used to obtain the bulk sediment (GSC-4297) produced the AMS age of 11.4 ka BP (TO-3880). This younger age is similar to basal AMS dates at other sites in the area and

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suggests that the bulk dates may be anomalously old. It also places some doubt on the reliability of GSC-4265, the bulk sample date from about 35 cm higher in the section, which compared to other sites should date from about 11 ka or slightly younger (Mott, 1994).

Brookfield series

A section through a bog and lake sediment sequence overlying varved clays and till was exposed during removal of overburden to expose limestone bedrock at the Brookfield site at the Canada Cement Lafarge Ltd. limestone quarry on the west side of Brookfield, Nova Scotia (45°14′20″N, 63°20′35″W). The site is in the Shubenacadie River valley at an elevation of about 42 m. The material was collected by R.J. Mott and V.K. Prest on August 15, 1981. All samples were submitted by R.J. Mott.

GSC-3635. Brookfield (I)

uncorrected age: 9140 ± 170

The wood, sample MS-81-25 (*Abies balsamea*, identified by R.J. Mott (unpublished GSC Wood Report No. 83-17)), was enclosed in algal gyttja. The sample (3.7 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The age estimate is based on two counts for 4180 minutes (two 1-day) in the 2 L counter with a mixing ratio of 2.57.

GSC-3652. Brookfield (II)

normalized age: 9780 ± 90
$\delta^{13}C$ = -24.4‰
uncorrected age: 9770 ± 90

The lake sediment, algal gyttja sample MS-81-25 A (170.0 g wet weight), was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The age estimate is based on one count for 4200 minutes (one 3-day) in the 5 L counter with a mixing ratio of 1.00.

TO-3970. Brookfield (III)

normalized age: 10 870 ± 80

The wood, sample MS-81-25 (175–180 cm) (small twigs, not identifiable), was enclosed in clay with silt and sand seams. The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (R.J. Mott): Two dates (*see* GSC-3635 and GSC-3652 above) from this site were reported previously in McNeely and McCuaig (1991). These relate to the base of the Holocene organic sequence overlying less organic mineral-rich sediments correlated with the Allerød/Younger Dryas climatic oscillation (Mott et al., 1986; Stea and Mott, 1989). The new AMS date (TO-3970) on twigs of 10 870 ± 80 BP is from an interval in marly organic silty clay 15 cm above the contact with underlying red laminated clay and 27 cm below the contact with overlying noncalcareous silty clay. This date indicates that the glacial lake, represented by the laminated red clays, drained only a short time prior to the onset of the Younger Dryas cold interval, represented by the noncalcareous silty clay. Pollen analysis indicates that shrub tundra communities occupied the site during that time interval.

The difference in age of 640 years between the wood and the enclosing gyttja (GSC-3635 and GSC-3652) emphasizes the possibility of obtaining an anomalous date from lake sediments even though free carbonates are not present in the sediment dated. At the Brookfield site, the bedrock is limestone and carbonates are present in the till, laminated sediments, and basal lake sediments, indicating that carbonates were probably present in the basin at the time of deposition of the algal gyttja. Although dating was not attempted on the underlying sediments, the late-glacial climatic oscillation equivalent to the Allerød/Younger Dryas of Europe (Mott et al., 1986) is recorded at this site on the basis of lithology and palynological studies.

GSC-5969 HP. Carrolls Corner

>48 000
$\delta^{13}C$ = -23.9‰

The wood (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 95-29)) was enclosed in clay. Sample 94-1-1 was collected by R. Grantham and K. Kozera on January 01, 1992, from a sinkhole 3 m below the exposed surface of a graded excavation in the National Gypsum Company quarry, Carrolls Corner, Nova Scotia (45°00′30″N, 63°25′00″W), at an elevation of 30 m. The sample was submitted by R.R. Stea and R.J. Mott to gain information on the paleobiology of a mastodon site.

The sample (37.9 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (30.4 g) yielded 29.38 L of CO_2 gas. The age estimate is based on one count for 5110 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.117 ± 0.034, 2.665 ± 0.025, and 100.864 ± 0.390 cpm, respectively.

Comment (R.J. Mott): The wood dates enclosing sediment. This date is part of a series of dates that relates to paleobiological sites in the region (GSC-33 >33.8 ka, GSC-3861 >50 ka, GSC-1642 >50 ka, GSC-5308 >38 ka) and this one contained mastodon remains that probably date from near the close of the last interglacial (Harington et al., 1993).

East Milford series

A series of wood samples from an open-pit gypsum mine at East Milford, about 50 km north of Halifax, Nova Scotia (45°00′30″N, 63°25′00″W), at an elevation of 30 m, were collected by R.R. Stea, R. Boyd, and S. Nichol on October 24, 1991. The samples were submitted by R.J. Mott.

GSC-5308. East Milford (I)

>38 000
$\delta^{13}C$ = -27.0‰

The wood, sample 91-East Milford-Stea (PL-91-79; 18.2 g wet weight; *Pinus banksiana*, identified by R.J. Mott (unpublished GSC Wood Report No. 91-57)), enclosed in clay with silt, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.4 g) yielded 8.70 L of CO_2 gas. The age estimate is based on one count for 3260 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.081 ± 0.037, 2.107 ± 0.027, and 28.215 ± 0.129 cpm, respectively.

GSC-5986 HP. East Milford (II)

>51 000
$\delta^{13}C$= -25.9‰

The wood, sample 91-East Milford-Stea (PL-91-79; 37.9 g wet weight; *Pinus banksiana*, identified by R.J. Mott (unpublished GSC Wood Report No. 91-57)), enclosed in clay with silt, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (32.3 g) yielded 29.85 L of CO_2 gas. The age estimate is based on one count for 1802 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were -0.002 ± 0.041, 2.660 ± 0.037, and 100.223 ± 0.317 cpm, respectively.

GSC-5849. East Milford quarry

>37 000
$\delta^{13}C$ = -28.4‰

The wood (deciduous; too poorly preserved to identify (unpublished GSC Wood Report No. 94-89)) was enclosed in sand. Sample 94-23-1 was collected by R.R. Stea in August, 1994, from the East Milford quarry, Hants County, Nova Scotia (45°00′30″N, 63°25′00″W), at an elevation of 30 m; it was submitted by R.R. Stea.

The sample (5.1 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (4.3 g) yielded 4.48 L of CO_2 gas. The age estimate is based on one count for 3260 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.064 ± 0.029, 1.228 ± 0.021, and 18.462 ± 0.140 cpm, respectively.

Comments (R.J. Mott): GSC-5986 HP is a high-pressure date on the same wood used for GSC-5308. All samples were recovered from units beneath Wisconsin glacial deposits and relate to the last interglacial interval or possibly to pre-Wisconsinan interstadial intervals (Mott, 1990).

Little Dyke Lake series

A series of lake sediments and organic detrital wood samples from Little Dyke Lake, about 2 km southwest of Glenholme, Colchester County, Nova Scotia (45°23′08″N, 63°33′35″W), at an elevation of about 10 m, were collected by R.J. Mott and M. Frappier on July 21, 1991, and by R.J. Mott on June 28, 1990; all samples were submitted by R.J. Mott.

TO-3976. Little Dyke Lake (I)

normalized age: 10 320 ± 80

The organic fragments and wood twigs, sample 91-MS-01 II (635–636 cm; 150 mg dry weight), were enclosed in gyttja and sandy silt. The age is normalized to a $\delta^{13}C$ of -25‰.

TO-3576. Little Dyke Lake (II)

normalized age: 10 930 ± 110

The organic fragments and wood twigs, sample 91-MS-01 (661–662 cm), were enclosed in gyttja and sandy silt. The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-5107. Little Dyke Lake (III)

normalized age: 10 500 ± 170
$\delta^{13}C$ = -22.8‰
uncorrected age: 10 500 ± 170

The lake sediment, a silty gyttja sample (90-MS-03, 692–696 cm; 108 g wet weight), enclosed in gyttja and sandy silt, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (32.3 g) yielded 3.56 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 1.26. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.920 ± 0.070, 1.092 ± 0.024, 18.125 ± 0.241 cpm, respectively.

GSC-5167. Little Dyke Lake (IV)

normalized age: 12 000 ± 210
$\delta^{13}C$ = -24.6‰
uncorrected age: 12 000 ± 210

The lake sediment, a silty gyttja sample (90-MS-03, 706.5–709 cm; 41.8 g wet weight), enclosed in gyttja and sandy silt, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (7.7 g) yielded 1.99 L of CO_2 gas. The age estimate is based on two counts for 2030 minutes in the 2 L counter with a mixing ratio of 2.20. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.173 ± 0.099, 1.099 ± 0.023, 18.484 ± 0.104 cpm, respectively.

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Beta-54888. Little Dyke Lake (V)
CAMS-3234.

normalized age: 11 560 ± 90

The wood, sample 90-MS-03 (741 cm; 698 mg dry weight), was enclosed in basal organic sediment. The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (R.J. Mott): GSC-5107 dates the resumption of organic deposition in the lake following the deposition of mineral sediment during the Younger Dryas cooling. The date is slightly older than anticipated, which may be an indication of a hard-water error. However, the mineral layer may not represent the complete cool period, but rather the time of maximum reworking of the sediments from the surrounding landscape.

General comments (R.J. Mott): GSC-5167 (12 000 ± 210) is obviously anomalous when compared to the AMS date Beta-54888 (11 560 ± 90) that is more than 30 cm lower in the core. A detailed pollen analysis (Frappier, 1996) shows changes similar to those at numerous other sites in Nova Scotia with herbaceous and shrub spectra at the base followed by a peak in spruce (*Picea*). A subsequent decline in spruce and return of shrub and herbs is succeeded by a return of spruce and other arboreal taxa. This sequence is indicative of a warm or warming climate followed by deglaciation and colder conditions during the Younder Dryas cold interval, and then a return to a warmer climate (Mott, 1994). The pollen shows that TO-3576 (10 930 ± 110) appears to be too young for its stratigraphic position. GSC-5107 (10 500 ± 700) is about 500 years too old, probably due to hard-water error. TO-3976 (10 320 ± 80) appears valid based on its stratigraphic position.

Wigmore Lake series

Wigmore Lake is a small, shallow lake (maximum water depth 2 m) in the lowland between the Northumberland Strait and Cobequid Highlands, about 5 km north of town of Mahoneys Corner (formerly Leroy), Cumberland County, Nova Scotia (45°44.0′N, 63°38.16′W), at an elevation of about 73 m. A core, taken with a modified Livingstone corer, shows the following stratigraphy: a surficial dark algal gyttja gradually decreases in organic content below 300 cm depth to form a medium brown silty gyttja at a depth of 517 cm. The organic content is low and varies toward the base of the core, but increases slightly just above 517 cm. The organic sediments overlie 27 cm of noncalcareous pink clay, which overlies calcareous red sand to the base of the core at 568 cm depth. The core was collected by R.J. Mott on June 30, 1990. R.J. Mott submitted the material for GSC-5567 and H. Jetté submitted the material for Beta-66119.

Beta-66119. Wigmore Lake (I)

normalized age: 6590 ± 170

The lake sediment, gyttja sample 90-MS-05 (276–280 cm), was enclosed in gyttja. The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-5567. Wigmore Lake (II)

normalized age: 11 400 ± 140
$\delta^{13}C$ = -24.8‰
uncorrected age: 11 400 ± 140

The lake sediment, basal silty gyttja sample 90-MS-05 (513–517 cm; 29.0 g wet weight), enclosed in silty gyttja and overlying red clay, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (31 g) yielded 2.6 L of CO_2 gas. The age estimate is based on one count for 3700 minutes in the 2 L counter with a mixing ratio of 1.73. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.464 ± 0.065, 1.179 ± 0.020, and 18.355 ± 0.109 cpm, respectively.

Comments (R.J. Mott): Beta-66119 approximates the 6 ka interval in the sediments that were used for pollen analysis to determine the environmental conditions at that time (Jetté and Mott, 1995). Within the organic sediments overlying the basal mineral sediments, the slightly greater organic content at the base followed by an interval of sediments with less organic content and then by highly organic sediments is reminiscent of the stratigraphy in numerous lakes throughout the Maritimes where this sediment sequence has been correlated with the Allerød/Younger Dryas climatic oscillation (Mott et al., 1986; Stea and Mott, 1989). If the basal date is valid, then the chronology corroborates this interpretation. However, the area must have been free of ice for only a short time before reversion of the climate to cooler conditions during the Younger Dryas interval. Further dating and pollen analysis are required to verify this interpretation.

Sutherland Lake

Sutherland Lake is a small, elongate lake in a narrow bedrock valley at the drainage divide in the Cobequid Highlands. The core was taken at the southern end of the lake in a water depth of about 6 m with a modified Livingstone corer. The corer penetrated to refusal in grey clay with abundant pebbles at 376 cm below the mud-water interface. The core shows pinkish-grey clay above to 363 cm overlain by grey-brown clayey gyttja and darker greenish-brown and brown gyttja to the surface.

GSC-5571. Sutherland Lake

normalized age: 10 100 ± 110
$\delta^{13}C$ = -21.5‰
uncorrected age: 10 100 ± 110

The lake sediment, basal clayey gyttja, was enclosed in gyttja over pink clay. Sample 90-MS-04 (361–363 cm) was collected by H. Jetté on July 1, 1990, from Sutherland Lake, about 12 km south of town of Westchester Station, Cobequid Mountains, Cumberland County, Nova Scotia (45°31.13′N, 63°40.30′W), at an elevation of about 230 m; it was submitted by R.J. Mott.

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The sample (90.0 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (19 g) yielded 2.9 L of CO_2 gas. The age estimate is based on one count for 4980 minutes in the 2 L counter with a mixing ratio of 1.58. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.238 ± 0.057, 1.179 ± 0.020, and 18.355 ± 0.109 cpm, respectively.

Comments (R.J. Mott): The basal date of 10.1 ka BP appears to be a reliable age for the base of the Holocene organic sediment. A late-glacial lithological record indicative of a climatic oscillation as seen at many sites throughout the Maritimes is not apparent at this site, suggesting the possibility of late ice in the late glacial in the Cobequid Highlands (Stea and Mott, 1989).

Leake Lake

Leake Lake is a kettle lake in a delta formed at the high late-glacial sea level along the northern coast of the Minas Basin. The lake was cored originally by D. Wightman in his study of the Quaternary geology of the Parrsboro area (Wightman, 1980). Samples from the core were dated at Dalhousie University and the Geological Survey of Canada with the latter dates being reported in Blake (1986). The two GSC dates were on the late-glacial sediments of low organic content beneath the Holocene organic sediments. These dates (GSC-2880, 15 900 ± 1200, and GSC-2728, 12 900 ± 160) were considered to be anomalously old. However, pollen analysis showed changes consistent with a possible late-glacial climatic oscillation in the basal sediments.

TO-3971. Leake Lake

normalized age: 12 260 ± 90

The wood, small twigs (not identified), was enclosed in clayey organic lake sediment. Sample 86-MS-09 (576–601 cm) was collected by R.J. Mott on July 20, 1986, from Leake Lake, on the northern outskirts of Parrsboro, Nova Scotia (45°25′10″N, 64°21′00″W), at an elevation of about 40 m; it was submitted by R.J. Mott. The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (R.J. Mott): Because the site obviously records a late-glacial sequence similar to that seen at many other sites in the Maritimes that are correlated with the Allerød/Younger Dryas climatic oscillation (Mott et al., 1986; Stea and Mott, 1989), the site was re-cored by Mott in 1986. The core recovered showed the same stratigraphic sequence as before, but with slightly different thicknesses for the lithological units. The sequence comprises dark brown gyttja grading to grey-brown clayey gyttja to 522 cm below the mud-water interface overlying a soft, dark grey clay to 575 cm. This overlies a more organic-rich clay with dark organic bands to about 599 cm and reddish-grey clay and red silty sand to the base of the core at 680 cm depth.

This AMS age of 12.3 ka BP indicates that the original conventional dates on bulk sediments were indeed too old, but that the site became available for organic sedimentation very early after emergence from the sea and melting of the kettle-forming ice block. The date also confirms that the time frame for the late-glacial climatic oscillation is consistent with that determined at other sites.

Pat Kempton Lake series

Pat Kempton Lake, a small lake with a maximum water depth of 2 m, is 2.5 km southeast of Maitland Bridge and 1.3 km east of the main gate to Kejimkujik National Park, Nova Scotia (44°26.08′N, 65°10.15′W), at an elevation of 120 m on a granite upland. Coring penetrated to a depth of 550 cm beneath the mud-water interface. Soft dark brown gyttja grades through stiff greenish-grey to black silty gyttja at 310 cm where the sediment is a mottled grey and black silty gyttja. Below 310 cm, about 20 cm of grey silty gyttja graded into laminated black and grey organic silt then to a black silty clay at 450 cm. These sediments overlie yellow- and black-banded silty clay with abundant sulphides. Below this to the depth penetrated is grey clay with yellowish-grey banding that becomes gritty with depth. The core was collected by R.J. Mott and H. Jetté on July 16, 1989 and the samples were submitted by R.J. Mott.

Beta-66128. Pat Kempton Lake (I)

normalized age: 8250 ± 150

The lake sediment, gyttja sample 89-MS-07 (208–212 cm), was enclosed in gyttja. The age is normalized to a $\delta^{13}C$ of -25‰.

TO-3972. Pat Kempton Lake (II)

normalized age: 11 610 ± 90

The wood, twigs, and leaf fragments, sample 89-MS-07 (445–450 cm), enclosed in yellow or black silty clay gyttja, were not identified. The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-5031. Pat Kempton Lake (III)

normalized age: 11 900 ± 270
$\delta^{13}C$ = -21.2‰
uncorrected age: 11 800 ± 270

The lake sediment, a black gyttja sample 89-MS-07 (450–454 cm; 174.3 g wet weight), enclosed in yellow or black gyttja, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (38.8 g) yielded 1.33 L of CO_2 gas. The age estimate is based on one count for 3440 minutes in the 2 L counter with a mixing ratio of 3.34. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.070 ± 0.131, 0.990 ± 0.030, and 17.773 ± 0.104 cpm, respectively.

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Comment (R.J. Mott): The basal date (GSC-5031) of 11.9 ka is only about 300 years older than the AMS date (TO-3972) of 11.6 ka obtained on twig and leaf fragments from the increment immediately above that used for the bulk date. Therefore, the basal organic sediment reliably predates 11 ka BP and the Younger Dryas cold interval that is recorded at many sites throughout the Maritimes (Mott et al., 1986; Stea and Mott, 1989). Further dating and pollen analysis will be required to document the climatic oscillation, which, because of the dark colour of the basal sediments in this core, is not as readily discernable as it is at most sites.

Quebec

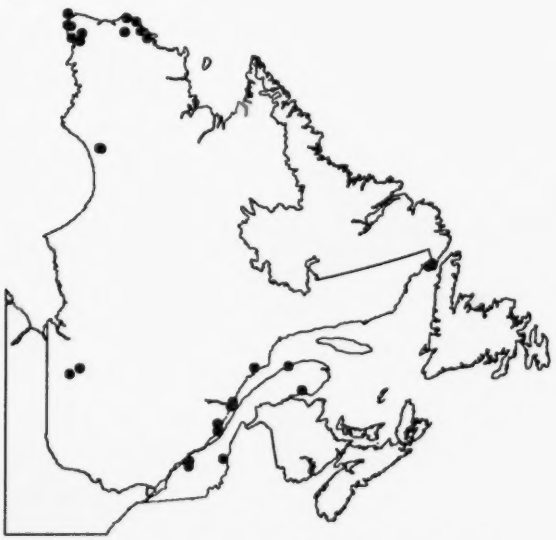

***Figure 3.** Radiocarbon-dated sites in Quebec.*

Blanc-Sablon River valley series

A series of peat samples from a palsa site in the upstream section at the head of the Blanc-Sablon River valley, Lourdes-de-Blanc-Sablon, Quebec (51°29′30″N, 57°09′30″W), at an elevation of about 60 m, was collected by J-C. Dionne in September 1991 and on October 16, 1992. The samples were submitted by J-C. Dionne.

GSC-5495. Blanc-Sablon (I)

modern

The peat sample, BS-5-91 (10 cm; 25.3 g dry weight), enclosed in peat, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (11.4 g) yielded 6.62 L of CO_2 gas. The age estimate is based on one count for 3291 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 28.193 ± 0.105, 2.193 ± 0.042, and 28.163 ± 0.147 cpm, respectively.

Comment (GSC Laboratory): This modern (98.8 pMC) sample indicates a time period around AD 1950 or slightly earlier.

GSC-5630. Blanc-Sablon (II)

normalized age:	430 ± 50
$\delta^{13}C$ =	-25.4‰
uncorrected age:	430 ± 50

The peat sample, BS-2-92 (27.1 g dry weight), enclosed in palsa peat bog, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.4 g) yielded 8.31 L of CO_2 gas. The age estimate is based on two counts for 2285 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 26.642 ± 0.116, 2.193 ± 0.027, and 28.110 ± 0.129 cpm, respectively.

GSC-5484. Blanc-Sablon (III)

normalized age:	620 ± 60
$\delta^{13}C$ =	-25.0‰
uncorrected age:	620 ± 60

The peat sample, BS-1-91 (20 cm; 21.0 g dry weight; *Sphagnum*, identified by J-C. Dionne), enclosed in peat, was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (6.6 g) yielded 5.40 L of CO_2 gas. The age estimate is based on two counts for 2250 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 16.966 ± 0.093, 1.200 ± 0.024, and 18.324 ± 0.104 cpm, respectively.

GSC-5623. Blanc-Sablon (IV)

normalized age:	740 ± 50
$\delta^{13}C$ =	-25.6‰
uncorrected age:	750 ± 50

The peat sample, BS-1-92 P (31.5 g dry weight; *Sphagnum* and lichens, identified by J-C. Dionne), enclosed in palsa peat bog, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (12.0 g) yielded 12.45 L of CO_2 gas. The age estimate is based on one count for 2490 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 25.595 ± 0.109, 2.193 ± 0.027, and 28.110 ± 0.129 cpm, respectively.

GSC-5488. Blanc-Sablon (V)

normalized age:	860 ± 60
$\delta^{13}C$ =	-26.3‰
uncorrected age:	880 ± 60

The peat sample, BS-2-91 (27 cm; 25.1 g dry weight), enclosed in peat, was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (13.5 g) yielded 8.63 L of CO_2 gas. The age estimate is based

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on two counts for 2250 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 25.235 ± 0.118, 2.193 ± 0.042, and 28.163 ± 0.147 cpm, respectively.

GSC-5493. Blanc-Sablon (VI)

normalized age: 1340 ± 70
$\delta^{13}C$ = -26.5‰
uncorrected age: 1360 ± 70

The peat, sample BS-3-91 (43 cm; 25.3 g dry weight; *Sphagnum*, identified by J-C. Dionne), enclosed in peat, was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (20.0 g) yielded 7.51 L of CO_2 gas. The age estimate is based on two counts for 2195 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 23.761 ± 0.159, 2.193 ± 0.042, and 28.163 ± 0.147 cpm, respectively.

GSC-5632. Blanc-Sablon (VII)

normalized age: 1410 ± 60
$\delta^{13}C$ = -26.5‰
uncorrected age: 1430 ± 60

The peat sample, BS-3-92 (24.8 g dry weight), enclosed in palsa peat bog, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (9.6 g) yielded 9.59 L of CO_2 gas. The age estimate is based on two counts for 2185 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 23.540 ± 0.120, 2.165 ± 0.052, and 28.136 ± 0.136 cpm, respectively.

GSC-5494. Blanc-Sablon (VIII)

normalized age: 2100 ± 60
$\delta^{13}C$ = -26.1‰
uncorrected age: 2120 ± 60

The peat sample, BS-4-91 (60 cm; 26.2 g dry weight), enclosed in peat, was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (12.3 g) yielded 8.71 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.622 ± 0.117, 2.193 ± 0.042, and 28.163 ± 0.147 cpm, respectively.

GSC-5634. Blanc-Sablon (IX)

normalized age: 2280 ± 60
$\delta^{13}C$ = -25.6‰
uncorrected age: 2290 ± 60

The peat sample, BS-4-92 (24.8 g dry weight), enclosed in palsa peat bog, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.8 g) yielded 8.79 L of CO_2 gas. The age estimate is based on two counts for 2120 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.146 ± 0.117, 2.165 ± 0.052, and 28.136 ± 0.136 cpm, respectively.

Comment (J-C. Dionne): The samples (GSC-5495, GSC-5484, GSC-5488, GSC-5493, and GSC-5494), with dates ranging in age from modern to 2.1 ka, were taken in 1991 from a vertical section in the peat cover of a palsa at depths of 10, 20, 27, 43 and 60 cm, respectively. Additional samples were taken in 1992 (GSC-5623, GSC-5630, GSC-5632, and GSC-5634), from the upper part of the peat cover, and are in good agreement with the previous series from the same palsa site. They indicate relatively continuous humid conditions in the peat bog during the last 2 ka, and confirm that the top peat layer of the palsa was eroded. Similar ages from two other palsa (GSC-4991, GSC-5010, GSC-5012, and GSC-5014; GSC-4881 (McNeely and Jorgensen, 1993), UL-692, and Beta-31932) suggest continuous peat growth in a shallow lake from 8.3 ka (GSC-4952, McNeely and Jorgensen, 1993) up to about 400 BP, and permafrost inception during the Little Ice Age.

GSC-5608. Lourdes-de-Blanc-Sablon

normalized age: 9730 ± 80
corrected age: 9330 ± 80
$\delta^{13}C$ = -1.05‰
uncorrected age: 9350 ± 80

The marine shell fragments (*Mya truncata*, identified by J-C. Dionne) were enclosed in gravel and sand. Sample BS-1-92 S was collected by J-C. Dionne on October 17, 1992, from a Lourdes-de-Blanc-Sablon gravel pit about 1 km southwest of the airport strip, 1 km east of Anse des Dunes, Quebec (51°25′40″N, 57°25′40″W), at an elevation of 25 to 30 m. The sample was submitted by J-C. Dionne.

The sample (51.0 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (34.5 g) yielded 7.92 L of CO_2 gas. The age estimate is based on one count for 3750 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.782 ± 0.061, 2.193 ± 0.027, and 28.110 ± 0.129 cpm, respectively.

Comment (J-C. Dionne): The age is apparently correct. It agrees well with the preliminary isostatic curve by Bigras and Dubois (1987). This date will be useful in developing a more accurate curve.

Lac à Raymond series

A series of lake sediment basal gyttja samples from Lac à Raymond, 6 km north of New Richmond, Gaspésie, Quebec (48°14′03″N, 65°50′58″W), at an elevation of 50 m, were collected by H. Jetté, P. Richard, and R.J. Mott on July 7, 1989. The samples were submitted by H. Jetté.

GSC-5276. Lac à Raymond (I)

normalized age: 3140 ± 100
$\delta^{13}C$ = -29.0‰
uncorrected age: 3200 ± 100

The lake sediment, gyttja, sample MS-89-02 (288–291 cm; 68.0 g wet weight), enclosed in gyttja, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (5.0 g) yielded 2.40 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 1.87. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.163 ± 0.126, 1.216 ± 0.026, and 18.122 ± 0.101 cpm, respectively.

GSC-5279. Lac à Raymond (II)

normalized age: 6470 ± 110
$\delta^{13}C$ = -29.7‰
uncorrected age: 6540 ± 110

The lake sediment, gyttja, sample MS-89-02 (759–761 cm; 58.2 g wet weight), enclosed in gyttja, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (12.0 g) yielded 2.72 L of CO_2 gas. The age estimate is based on two counts for 2220 minutes in the 2 L counter with a mixing ratio of 1.63. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.025 ± 0.095, 1.216 ± 0.026, and 18.122 ± 0.101 cpm, respectively.

TO-2694. Lac à Raymond (III)

normalized age: 5990 ± 60

The terrestrial remains including needles, sample MS-89-02 (759–761 cm; 0.018 g dry weight; *Pinus, Abies,* and *Picea,* identified by H. Jetté), were enclosed in lake gyttja containing carbonates. The age is normalized to a $\delta^{13}C$ of -25‰.

GSC-4922. Lac à Raymond (IV)

normalized age: 12 000 ± 240
$\delta^{13}C$ = -29.4‰
uncorrected age: 12 100 ± 240

The lake sediment, basal gyttja, sample MS-89-02 (1026–1032 cm; 26.0 g wet weight), overlying clay, was treated with hot acid (moderately calcareous) and distilled water rinses. The base treatment was omitted. The treated sample (27.7 g) yielded 1.37 L of CO_2 gas. The age estimate is based on one count for 2930 minutes in the 2 L counter with a mixing ratio of 3.26. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.952 ± 0.110, 1.083 ± 0.019, and 17.862 ± 0.102 cpm, respectively.

TO-1613. Lac à Raymond (V)

normalized age: 10 150 ± 220

The wood fragments, sample MS-89-02 (1030–1032 cm; *Salix*, identified by J.V. Matthews, Jr.), were enclosed in basal gyttja. The age is normalized to a $\delta^{13}C$ of -25‰.

Comment (H. Jetté): Two out of three dates on gyttja for this series have been redone on selected terrestrial material, using AMS technology. GSC-5279 yielded an age of 6470 ± 110 whereas TO-2694 reported an age of 5990 ± 60 (a difference of 480 years). GSC-4922 yielded an age of 12 000 ± 240 whereas TO-1613 reported an age of 10 150 ± 220 (a difference of 1850 years). The sediment submitted for GSC-4922 contained 15% carbonate and the sediment submitted for GSC-5279 contained 13.3% carbonate. The difference between conventional (on gyttja) and AMS dates (on terrestrial remains) for that series is attributed to hard-water error. A carbonate content of 10.5% for GSC-5276 would indicate the possibility of a hard-water effect at that level as well (Jetté and Richard, 1992).

Perdu Lake series

A series of lake sediment samples from Perdu Lake, 1 km due south of Ruisseau du Castor, 11 km east of Sainte-Anne-des-Monts, Gaspésie, Quebec (49°10′05″N, 66°19′25″W), at an elevation of 152 m, was collected by P.J.H. Richard and C. Labelle on April 11, 1980. The samples were submitted by P.J.H. Richard.

GSC-5288. Perdu Lake (I)

normalized age: 1960 ± 120
$\delta^{13}C$ = -29.4‰
uncorrected age: 2030 ± 120

The lake sediment, gyttja, sample Perdu-C (128–132 cm; 65.9 g wet weight), enclosed in organic lake mud, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (1.7 g) yielded 1.49 L of CO_2 gas. The age estimate is based on two counts for 1906 minutes in the 2 L counter with a mixing ratio of 3.02. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.187 ± 0.191, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

GSC-5291. Perdu Lake (II)

uncorrected age: 13 300 ± 150

The lake sediment, gyttja, sample Perdu-C (448–452 cm; 144.4 g wet weight), enclosed in organic lake mud, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (4.6 g) yielded 1.76 L of CO_2 gas. The age estimate is based on two counts for 2040 minutes in the 2 L counter with a mixing ratio of 1.00.

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The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.479 ± 0.055, 1.216 ± 0.026, and 18.122 ± 0.101 cpm, respectively.

GSC-5292. Perdu Lake (III)

normalized age:	9050 ± 140
$\delta^{13}C$ =	-28.3‰
uncorrected age:	9100 ± 140

The lake sediment, gyttja, sample Perdu-C (596–600 cm; 13.6 g wet weight), enclosed in organic lake mud, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (11.9 g) yielded 3.69 L of CO_2 gas. The age estimate is based on one count for 3600 minutes in the 2 L counter with a mixing ratio of 1.21. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.922 ± 0.087, 1.188 ± 0.059, and 18.396 ± 0.155 cpm, respectively.

Comment (P.J.H. Richard): GSC-5291 is anomalous, but the other two dates (GSC-5292 and GSC-5288) fall close to the age-depth curve developed using AMS dates on terrestrial macrofossils (*see* Richard et al., 1997, comments and Fig. 4).

GSC-5337. Inconnu Lake

normalized age:	9860 ± 120
$\delta^{13}C$ =	+1.7‰
corrected age:	9460 ± 120
uncorrected age:	9430 ± 120

The marine shells (*Zirphaea crispata*, identified by J.M. Topping) were enclosed in sand. Sample 'LaSalle-91-1' was collected by P. LaSalle on August 15, 1991, from about 100 km north of Baie-Comeau, near Inconnu Lake, Quebec (49°19′30″N, 68°09′30″W), at an elevation of 75 m. The sample was submitted by P. LaSalle.

The sample (20.5 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (19.2 g) yielded 4.28 L of CO_2 gas. The age estimate is based on two counts for 2140 minutes in the 2 L counter with a mixing ratio of 1.05. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.649 ± 0.065, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

Comment (P. LaSalle): Marine shells of several species were present and very abundant in this pit. They are mixed with about 10% to 20% sand. About 9.5 ka BP, the sea waters formed a very narrow shallow bay in the Rivière des Anglais valley north of Baie-Comeau. Conditions must have been very favorable for marine life. The date suggests that sea level was about or a little more than 75 m above the present-day level at the time of shell growth. The species dated, *Zirphaea crispata*, was rare in the pit. The most abundant species were *Mytilus edulis* and *Hiatella arctica*.

GSC-5390. Petites-Bergeronnes

normalized age:	6420 ± 90
corrected age:	6020 ± 90
$\delta^{13}C$ =	+0.5‰
uncorrected age:	6010 ± 90

The marine shells (*Mya arenaria*, identified by J-C. Dionne) were enclosed in silty clay and fine sand of intertidal deposits overlying marine clay. Sample TAD-11-91 was collected by J-C. Dionne in June 1991 from Rivière des Petites Bergeronnes, 2.5 km west of Grandes-Bergeronnes, on the north shore of the St. Lawrence estuary (Saguenay), Quebec (48°14′10″N, 69°34′45″W), at an elevation of 4 m. The sample was submitted by J-C. Dionne.

The sample (44.1 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (35.1 g) yielded 7.85 L of CO_2 gas. The age estimate is based on two counts for 2235 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.240 ± 0.093, 2.185 ± 0.041, and 27.969 ± 0.203 cpm, respectively.

Comment (J-C. Dionne): This age was obtained on shells in living position in silty clay and sand of an intertidal deposit overlying marine clay (Goldthwait Sea). The age suggests a relatively low sea level at that time. The intertidal deposit forms the substrate of the Mitis Terrace in the downstream section of the Rivière des Petites Bergeronnes valley.

Sainte Catherine Bay series

A series of wood and organic debris samples from 2 km south of Sainte Catherine Bay, on the north shore of the St. Lawrence estuary (Saguenay), Quebec (between 48°05′N, 69°43′30″W and 48°05′40″N, 69°42′45″W), at elevations of 4.5, 5, and 6.5 m, were collected by J-C. Dionne in June 1990 and 1991. All samples were submitted by J-C. Dionne.

GSC-5321. Sainte Catherine Bay (I)

normalized age:	1120 ± 60
$\delta^{13}C$ =	-26.2‰
uncorrected age:	1140 ± 60

The wood, sample TAD-4-91 (232 cm; 21.0 g dry weight; *Abies balsamea*, identified by H. Jetté (unpublished GSC Wood Report No. 91-83)), enclosed in silt-clay, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.4 g) yielded 8.49 L of CO_2 gas. The age estimate is based on two counts for 1690 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 24.492 ± 0.129, 2.107 ± 0.027, and 28.215 ± 0.129 cpm, respectively.

Comment (J-C. Dionne): The age is younger than expected. The median of 17 dates for the intertidal deposit of the Mitis Terrace is 1370 ± 70 (UL-839). However, a similar

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age of 1160 ± 60 (Beta-18334) has been obtained on another piece of wood in the same unit. *See* comment for GSC-5317, below.

GSC-5317. Sainte Catherine Bay (II)

normalized age:	1260 ± 50
$\delta^{13}C$ =	-25.3‰
uncorrected age:	1260 ± 50

The wood, sample TAD-3-91 (20.0 g dry weight; *Pinus strobus*, identified by H. Jetté (unpublished GSC Wood Report No. 91-58)), enclosed in clay, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.4 g) yielded 8.08 L of CO_2 gas. The age estimate is based on two counts for 1985 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 24.104 ± 0.119, 2.107 ± 0.027, and 28.215 ± 0.129 cpm, respectively.

Comment (J-C. Dionne): The age is slightly too old for mudflows covering the surface of the Mitis (6 m) Terrace. A younger age (GSC-5321) was obtained at the same exposure on a piece of *Abies balsamea* in an intertidal deposit underlying the mudflow. However, similar dates have been obtained previously on tree trunks in other mudflows in the same area: 1260 ± 60 (UL-323), 1360 ± 70 (UL-470), and 1180 ± 60 (Beta-36106). *See* comment for GSC-5321, above.

GSC-5388. Sainte Catherine Bay (III)

normalized age:	1300 ± 50
$\delta^{13}C$ =	-24.0‰
uncorrected age:	1290 ± 50

The wood, sample TAD-1-91 (15.8 g dry weight; *Pinus resinosa*, identified by H. Jetté (unpublished GSC Wood Report No. 92-08)), enclosed in beach sand, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.5 g) yielded 8.33 L of CO_2 gas. The age estimate is based on one count for 2400 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 24.207 ± 0.109, 2.234 ± 0.029, and 28.421 ± 0.132 cpm, respectively.

Comment (J-C. Dionne): This date is in agreement with other dates for the beach deposit of the Mitis Terrace. The median of seven dates is 1290 ± 70 (Beta-24661).

GSC-5313. Sainte Catherine Bay (IV)

normalized age:	1950 ± 80
$\delta^{13}C$ =	-27.2‰
uncorrected age:	1980 ± 80

The organic debris (wood), sample TAD-7a-91 (6.8 g dry weight; *Betula*, identified by H. Jetté (unpublished GSC Wood Report No. 91-82)), enclosed in silty sand, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (5.9 g) yielded 6.04 L of CO_2 gas. The age estimate is based on two counts for 1970 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.152 ± 0.092, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

Comment (J-C. Dionne): This is a valuable date for the building of the Mitis Terrace, i.e. a change from intertidal to beach environment (shoreline emergence).

GSC-5333. Sainte Catherine Bay (V)

normalized age:	4510 ± 70
$\delta^{13}C$ =	-26.0‰
uncorrected age:	4530 ± 70

The wood, sample TAD-6-91 (19.0 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 91-89)), enclosed in beach sand overlying stratified silt and clay, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 8.29 L of CO_2 gas. The age estimate is based on two counts for 2200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 16.139 ± 0.097, 2.231 ± 0.034, and 28.364 ± 0.176 cpm, respectively.

Comment (J-C. Dionne): The age is much older than expected. If the enclosing sandy deposit is correctly identified as beach deposits, the piece of wood was probably redeposited after being eroded from an old landslide, which is a common feature in the area. However, two similar dates of 4270 ± 70 (Beta-28368) and 4380 ± 80 (GSC-5400) have been obtained on pieces of wood in the same unit in other exposures in the same area. If not redeposited, the piece of wood might date the Laurentian transgression.

GSC-5262. Veilleux River

normalized age:	10 200 ± 200
$\delta^{13}C$ =	-27.0‰
uncorrected age:	10 200 ± 200

The peat, sample 90SCA-038, was collected by W.W. Shilts on October 13, 1990, from the north shore of Veilleux River, 4 km northeast of Quatre-Chemins, near Saint-Prosper, 200 m southeast of Highway 204, Quebec (46°16′N, 70°28′W), at an elevation of 300 m. The sample was submitted by W.W. Shilts.

The sample (144.0 g wet weight) was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (18.5 g) yielded 5.17 L of CO_2 gas. The age estimate is based on two counts for 1920 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.299 ± 0.104, 1.224 ± 0.025, and 18.875 ± 0.273 cpm, respectively.

Comment (W.W. Shilts): The sample gives a minimum age for emplacement of outwash in the Veilleux River valley, but it is probably 1000 to 2000 years too young. The outwash was deposited by a retreating front of remnant Appalachian ice, near the Quebec Ice Divide. This date allows an estimation of the rate of peat accumulation along the alluvial flats, typical of this region. The sample was from a depth of about 2.5 m, at the base of a commercially exploited peat deposit.

GSC-5218. Maillard (I)

normalized age: 870 ± 60
$\delta^{13}C$ = -27.2‰
uncorrected age: 900 ± 60

The wood (*Betula*, identified by H. Jetté (unpublished GSC Wood Report No. 91-31)) was enclosed in silty sand. Sample PR-20-90 was collected by J-C. Dionne on October 20, 1990, from 0.7 km northeast of Maillard, Petite-Rivière, Charlevoix, north shore of the lower St. Lawrence estuary, Quebec (47°32′25″N, 70°32′25″W), at an elevation of 3.5 m. The sample was submitted by J-C. Dionne.

The sample (36.5 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.4 g) yielded 8.77 L of CO_2 gas. The age estimate is based on one count for 2200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 25.288 ± 0.118, 2.048 ± 0.039, and 28.302 ± 0.166 cpm, respectively.

GSC-5215. Maillard (II)

normalized age: 950 ± 60
$\delta^{13}C$ = -24.6‰
uncorrected age: 940 ± 60

The wood (*Pinus strobus*, identified by H. Jetté (unpublished GSC Wood Report No. 91-29)) was enclosed in silty sand. Sample PR-19-90 was collected by J-C. Dionne on October 20, 1990, from 0.5 km northeast of Maillard, Petite-Rivière, Charlevoix, on the north shore of the St. Lawrence estuary, Quebec (47°20′30″N, 70°32′22″W), at an elevation of 3.5 m. The sample was submitted by J-C. Dionne.

The sample (18.6 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.9 g) yielded 8.13 L of CO_2 gas. The age estimate is based on two counts for 2070 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 25.168 ± 0.121, 2.048 ± 0.039, and 28.302 ± 0.166 cpm, respectively.

Comment (J-C. Dionne): These ages are in good agreement with other dates for the base of the intertidal unit overlying glaciolacustrine sediments (varves) for the same area: 880 ± 50 (Beta-45282), 980 ± 80 (UL-534), and 1120 ± 60 (Beta-44572). This is a valuable date for the lower terrace east of Maillard.

GSC-5224. Maillard (III)

normalized age: 570 ± 50
$\delta^{13}C$ = -24.9‰
uncorrected age: 570 ± 50

The wood (*Abies* probably *balsamea*, identified by H. Jetté (unpublished GSC Wood Report No. 91-33)) was enclosed in silty fine sand. Sample PR-23c-90 was collected by J-C. Dionne on October 20, 1990, from 0.5 km northeast of Maillard, Petite-Rivière, Charlevoix, on the north shore of the St. Lawrence estuary, Quebec (47°20′25″N, 70°32′35″W), at an elevation of 6 m. The sample was submitted by J-C. Dionne.

The sample (19.6 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.6 g) yielded 8.38 L of CO_2 gas. The age estimate is based on two counts for 2400 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 26.405 ± 0.119, 2.055 ± 0.028, and 28.334 ± 0.123 cpm, respectively.

Comment (J-C. Dionne): The age is too young. At the same section, organic debris (plant remains) about 100 cm above were dated 770 ± 50 (Beta-44573), and a piece of wood 10 cm below the organic layer was dated 750 ± 50 (Beta-44571). In addition, two pieces of wood at about the same level as GSC-5224 were dated 1010 ± 60 (Beta-44572). However, this age is normal for the upper part of the intertidal unit in the area with the median of 29 dates being 650 BP.

GSC-5228. Petite-Rivière

normalized age: 1930 ± 60
$\delta^{13}C$ = -26.5‰
uncorrected age: 1950 ± 60

The organic debris (mixed) was enclosed in fine sand and stratified silt. Sample PR-12a-90 was collected by J-C. Dionne on October 17, 1990, from 3.8 km southwest of the village church, Petite-Rivière, Charlevoix, Quebec (47°16′20″N, 70°34′30″W), at an elevation of about 6 m. The sample was submitted by J-C. Dionne.

The sample (38.2 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (9.2 g) yielded 8.49 L of CO_2 gas. The age estimate is based on two counts for 1920 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 22.234 ± 0.129, 2.055 ± 0.028, and 28.334 ± 0.123 cpm, respectively.

Comment (J-C. Dionne): This date is in excellent agreement with other dates from other laboratories (e.g. UL and Beta) for the same unit at the same section. This is a valuable age on the intertidal deposit overlying an eroded surface cut into a diamicton (till). The age is close to the median of 23 dates for the lower terrace (Mitis Terrace) at Petite-Rivière (Charlevoix).

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GSC-5402. Petit-Saint-Louis

normalized age:	10 700 ± 120
corrected age:	10 300 ± 120
$\delta^{13}C$ =	-2.04‰
uncorrected age:	10 300 ± 120

The marine shells (whole valves and fragments of *Macoma balthica*, identified by A. Bolduc) were enclosed in sand and gravel. Sample 91-BZA-1069 was collected by A. Bolduc and M. Gagnon on August 3, 1991, from 4 km south of Petit-Saint-Louis, Quebec (46°15′50″N, 72°19′20″W), at an elevation of 61 m. The sample was submitted by A. Bolduc.

The sample (19.8 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (17.7 g) yielded 3.80 L of CO_2 gas. The age estimate is based on one count for 3895 minutes in the 2 L counter with a mixing ratio of 1.15. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.006 ± 0.052, 1.249 ± 0.025, and 18.139 ± 0.145 cpm, respectively.

Comment (A. Bolduc): The shells were found in a sand pit located near the lowest elevation for marine sediments in the area, and must therefore represent the last stages of the Champlain Sea. The age agrees with the Champlain Sea Stage III in the area, as reported in Parent and Occhietti (1988).

Gentilly River series

A series of marine shell samples from 0.75 km north of Thibodeau Falls on the Gentilly River, Quebec (46°20′25″N, 72°14′40″W), at an elevation of 65 m, were collected by A. Bolduc, A. Doiron, S. Paradis, and M. Parent on September 9, 1991. The samples were submitted by A. Bolduc.

GSC-5360. Gentilly River (I)

normalized age:	10 800 ± 120
corrected age:	10 400 ± 120
$\delta^{13}C$ =	-0.6‰
uncorrected age:	10 400 ± 120

The marine shells, sample 91-BZA-1068-A (23.5 g dry weight; *Macoma balthica* and *Balanus*, identified by A. Bolduc), enclosed in sand, were treated with an acid leach to remove the outer 20% of the sample. The treated sample (17.1 g) yielded 3.48 L of CO_2 gas. The age estimate is based on one count for 3730 minutes in the 2 L counter with a mixing ratio of 1.28. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.985 ± 0.058, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

Comment (A. Bolduc): The shells were found mostly as fragments, which implies some reworking of the material. This date is similar to GSC-5383 (10 400 ± 150 BP), but is located at a lower altitude than GSC-5383. The date seems too old, on the basis of the altitudinal difference, but may indicate reworking of older sediments. Although this date probably does not provide an age estimate for the last stages of the Champlain Sea, it does provide a maximum estimate for regression in the area.

Nevertheless, GSC-5360 provides a maximum estimate of the sedimentation rate (0.4 mm/100 a) in the area in conjunction with GSC-5394 (11 200 ± 100 BP), which came from 30 cm below.

GSC-5394. Gentilly River (II)

normalized age:	11 600 ± 100
corrected age:	11 200 ± 100
$\delta^{13}C$ =	+0.8‰
uncorrected age:	11 200 ± 100

The marine shell fragments, sample 91-BZA-1068-B (34.8 g wet weight; *Balanus hameri*, identified by A. Bolduc), enclosed in marine diamicton, were treated with an acid leach to remove the outer 10% of the sample. The treated sample (31.3 g) yielded 7.05 L of CO_2 gas. The age estimate is based on one count for 3700 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.021 ± 0.058, 2.234 ± 0.029, and 28.421 ± 0.132 cpm, respectively.

Comment (A. Bolduc): The marine diamicton in which the shells are found was most likely deposited during the Saint-Narcisse episode. GSC-5394 is in excellent agreement with GSC-1526 (11 500 ± 630 BP, Gadd et al., 1972), GSC-2045 (11 100 ± 90 BP, Occhietti, 1976), and GSC-1729 (11 300 ± 160 BP, Occhietti, 1980), all located near the Saint-Narcisse morainic system as far as 30 km south of the ice frontal position, which is significant.

It is interesting to note that the microfaunal assemblage present in this diamicton has been interpreted as similar to those found near the Saint-Narcisse moraine (foraminifera identified and interpreted by J.P. Guilbeault, pers. comm., 1992), and represents a fauna living in adverse conditions, possibly due to high sedimentation rates. It is significant that the microfauna are typical of the Saint-Narcisse area and that GSC-5394 dates that event, and yet the site is located a fair distance from the ice front. Glaciomarine sedimentation must have been widespread during the Saint-Narcisse episode and has had significant effects on the microfauna. Other sites with similar conditions need to be documented to assess just how far from the ice front such conditions prevailed.

GSC-5210. Wakeham River

normalized age:	1300 ± 60
$\delta^{13}C$ =	-25.8‰
uncorrected age:	1320 ± 60

The wood (*Salix*, identified by H. Jetté (unpublished GSC Wood Report No. 91-27)) was enclosed in sand. Sample 90-DKA-29 was collected by R.A. Daigneault on June 24, 1990, from the south bank of the Wakeham River, about

19 km west of Kangiqsujuaq, Ungava Peninsula, Nouveau-Québec (61°32′50″N, 72°17′15″W), at an elevation of 30 m. The sample was submitted by R.A. Daigneault.

The sample (9.4 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (7.2 g) yielded 6.85 L of CO_2 gas. The age estimate is based on one count for 3800 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 24.023 ± 0.092, 2.048 ± 0.039, and 28.302 ± 0.166 cpm, respectively.

GSC-5383. Saint-Wencelas

normalized age:	10 800 ± 150
corrected age:	10 400 ± 150
$\delta^{13}C$ =	-0.7‰
uncorrected age:	10 400 ± 150

The marine shells (*Macoma balthica* and *Mya arenaria*, identified by A. Bolduc) were enclosed in a sandy diamicton. Sample 91-BZA-1043A was collected by A. Bolduc, A. Doiron, S. Paradis, and M. Parent on September 9, 1991, from 4 km southeast of Saint-Wencelas, Quebec (46°8′20″N, 72°17′50″W), at an elevation of 88 m. The sample was submitted by A. Bolduc.

The sample (17.6 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (13.7 g) yielded 2.88 L of CO_2 gas. The age estimate is based on one count for 2460 minutes in the 2 L counter with a mixing ratio of 1.54. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.968 ± 0.078, 1.238 ± 0.028, and 18.133 ± 0.104 cpm, respectively.

Comment (A. Bolduc): The sample was collected from a reworked sandy diamicton, above which littoral sands deposited during the regression of the Champlain Sea were present. The presence of *Mya arenaria* indicates shallow water conditions (<10 m water depth), in agreement with the microfaunal content of the diamicton located below the fossiliferous unit (shallow water conditions, <10–20 m depth, foraminifera identified and interpreted by J.P. Guilbeault, pers. comm. 1992).

GSC-5383 dates the last stages of the Champlain Sea in the Saint-Wenceslas area, and is in agreement with UQ-947 at 10 350 ± BP (Parent, 1987), which was collected a few kilometres north of GSC-5383, at an elevation of 81 m.

GSC-5202. Kangiqsujuaq village

normalized age:	7430 ± 110
corrected age:	7030 ± 110
$\delta^{13}C$ =	1.82‰
uncorrected age:	7000 ± 110

The marine shells (*Mya truncata* and *Macoma calcarea*, identified by D. Bruneau) were enclosed in silty marine clay. Sample WB-4 was collected by J.T. Gray and D. Bruneau in 1989, from about 20 km southwest of Kangiqsujuaq village, on the left side of the last major junction of the Wakeham River, Quebec (61°33′N, 72°18′W), at an elevation of 10 m. The sample was submitted by J.T. Gray.

The sample (36.6 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (29.3 g) yielded 5.93 L of CO_2 gas. The age estimate is based on one count for 3940 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.645 ± 0.054, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

Comment (J.T. Gray): This date gives a reasonable indication of the age of deglaciation of the innermost reaches of the Wakeham Bay fiord. This is a late event, when viewed in the context of a date of 8470 ± 80 BP (TO-1738), recorded for the coastal foreland at De Martigny Promontory about 50 km to the north, and compared with reservoir corrected dates of 8160 ± 230 BP (TO-2465) and 8520 ± 80 BP (TO-2466) obtained by McLean et al. (1992), and a date of 8340 ± 70 (TO-3763) obtained by J.T. Gray (unpublished) from a glacio-marine sediment core, offshore from Wakeham Bay. However, it correlates well with non-fractionation corrected (and by implication reservoir corrected) ages of 7020 ± 90 (Beta-34762) and 6740 ± 100 (Beta-11101) obtained by Gray et al. (1993, Fig. 9) for the heads of former fiords immediately north of Wakeham Bay. The delay of 1.5 to 2 ka between deglaciation of the outer coast and the inner fiord zone is attributed to late persistence of an Ungava ice cap over the high northern Ungava plateau (> 600 m), which terminates abruptly at the coast, forming a series of steep-walled promontories, fiords, and sea-level cirques.

GSC-5207. Douglas Harbour

normalized age:	5500 ± 110
corrected age:	5110 ± 110
$\delta^{13}C$ =	+3.07‰
uncorrected age:	5060 ± 110

The marine shells (*Mya truncata ovata*, identified by R.A. Daigneault) were enclosed in fine sand. Sample 90-DKA-32 was collected by R.A. Daigneault on June 28, 1990, from the west bank of the river, 50 m from the mouth of Douglas Harbour, southwest arm, Ungava Peninsula, Nouveau-Québec (61°49′25″N, 72°42′55″W), at an elevation of 6 m. The sample was submitted by R.A. Daigneault.

The sample (33.2 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (26.9 g) yielded 5.33 L of CO_2 gas. The age estimate is based on two counts for 1830 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.739 ± 0.082, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

GSC-5211. Foul Bay

normalized age: 7620 ± 110
corrected age: 7220 ± 110
$\delta^{13}C$ = +2.20‰
uncorrected age: 7180 ± 110

The marine shells (*Mya truncata typica*, identified by R.A. Daigneault) were enclosed in silty clay. Sample 90-DKA-64 was collected by R.A. Daigneault on July 7, 1990, from Foul Bay on Hudson Strait, 5 km northeast of Tasialujjuaq Lake, Ungava Peninsula, Nouveau-Québec (62°09′50″N, 72°59′40″W), at an elevation of 15 m. The sample was submitted by R.A. Daigneault.

The sample (28.1 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (22.4 g) yielded 4.99 L of CO_2 gas. The age estimate is based on one count for 3400 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.472 ± 0.057, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

GSC-5209. Cap de Nouvelle-France

normalized age: 8090 ± 170
$\delta^{13}C$ = -19.0‰
uncorrected age: 8000 ± 170

The basal organic lake sediment, sample 90-DKA-207 (-78 cm), was collected by R.A. Daigneault on August 7, 1990, from 18 km south of Cap de Nouvelle-France, Ungava Peninsula, Nouveau-Québec (62°19′12″N, 73°41′16″W), at an elevation of 267 m. The sample was submitted by R.A. Daigneault.

The sample (102.0 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (19.8 g) yielded 3.43 L of CO_2 gas. The age estimate is based on two counts for 1795 minutes in the 2 L counter with a mixing ratio of 1.31. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.793 ± 0.133, 1.213 ± 0.021, and 18.379 ± 0.137 cpm, respectively.

GSC-5205. Purtuniq

normalized age: 4600 ± 100
$\delta^{13}C$ = -21.2‰
uncorrected age: 4540 ± 100

The lake sediment, basal organic sample 90-DKA-199 (-14 cm), was collected by R.A. Daigneault on August 6, 1990, from 3 km northeast of Purtuniq (Asbestos Hill), Ungava Peninsula, Nouveau-Québec (61°50′2″N, 73°54′46″W), at an elevation of 527 m. The sample was submitted by R.A. Daigneault.

The sample (124.1 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The treated sample (84.6 g) yielded 3.62 L of CO_2 gas. The age estimate is based on one count for 3800 minutes in the 2 L counter with a mixing ratio of 1.23. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.385 ± 0.070, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

GSC-5314. Boniface River (I)

normalized age: 2410 ± 80
$\delta^{13}C$ = -25.5‰
uncorrected age: 2410 ± 80

The wood (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 91-59)), sample EW5-A6 (65 cm), was collected by C. Lavoie, E. Marcoux, and M. Lévesque on July 31, 1991, from Boniface River, about 130 km southeast of Inukjuak, Quebec (57°45′N, 76°09′W), at an elevation of 135 m. The sample was submitted by C. Lavoie.

The sample (19.8 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.5 g) yielded 8.38 L of CO_2 gas. The age estimate is based on two counts for 2080 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 20.893 ± 0.182, 2.107 ± 0.027, and 28.215 ± 0.129 cpm, respectively.

GSC-5355. Boniface River (II)

normalized age: 2870 ± 60
$\delta^{13}C$ = -25.6‰
uncorrected age: 2880 ± 60

The wood (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-07)), sample EW3-A10 (85 cm), was collected by C. Lavoie, E. Marcoux, and M. Lévesque on July 7, 1991, from Boniface River, about 130 km southeast of Inukjuak, Quebec (57°44′N, 76°03′W), at an elevation of 140 m. The sample was submitted by C. Lavoie.

The sample (19.2 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.4 g) yielded 8.26 L of CO_2 gas. The age estimate is based on two counts for 1806 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.646 ± 0.115, 2.215 ± 0.033, and 28.129 ± 0.131 cpm, respectively.

GSC-5346. Boniface River (III)

normalized age: 2880 ± 60
$\delta^{13}C$ = -25.3‰
uncorrected age: 2880 ± 60

The wood, charcoal (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-02)), sample EW4-A5 (117 cm), was collected by C. Lavoie, E. Marcoux, and M. Lévesque on August 3, 1991, from Boniface River, about

130 km southeast of Inukjuak, Quebec (57°45′N, 76°05′W), at an elevation of 135 m. The sample was submitted by C. Lavoie.

The sample (18.9 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 8.04 L of CO_2 gas. The age estimate is based on two counts for 2160 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.650 ± 0.106, 2.215 ± 0.033, and 28.129 ± 0.131 cpm, respectively.

GSC-5353. Nammagiaq Hill

normalized age:	7190 ± 80
corrected age:	6790 ± 80
$\delta^{13}C$ =	+1.8‰
uncorrected age:	6764 ± 80

The marine shells (*Hiatella arctica*, identified by R.A. Daigneault) were enclosed in silty sand. Sample 91-DKA-86 was collected by R.A. Daigneault on July 5, 1991, from 7 km south of Nammagiaq Hill, Nouveau-Québec (61°52′14″N, 77°04′26″W), at an elevation of 67 m. The sample was submitted by R.A. Daigneault.

The sample (47.7 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (37.9 g) yielded 8.29 L of CO_2 gas. The age estimate is based on two counts for 2010 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.119 ± 0.095, 2.215 ± 0.033, and 28.129 ± 0.131 cpm, respectively.

GSC-5312. Bilson Lake

normalized age:	6510 ± 80
corrected age:	6110 ± 80
$\delta^{13}C$ =	+0.2‰
uncorrected age:	6110 ± 80

The marine shells (*Mytilus edulis*, identified by R.A. Daigneault) were enclosed in sand. Sample 91-DKA-201 was collected by R.A. Daigneault on July 25, 1991, from 15 km north of Bilson Lake, Nouveau-Québec (61°35′46″N, 77°15′00″W), at an elevation of 73 m. The sample was submitted by R.A. Daigneault.

The sample (45.9 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (36.9 g) yielded 8.15 L of CO_2 gas. The age estimate is based on two counts for 1900 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.190 ± 0.106, 2.107 ± 0.027, and 28.215 ± 0.129 cpm, respectively.

GSC-5339. Lake Matagami

normalized age:	7030 ± 80
$\delta^{13}C$ =	-26.4‰
uncorrected age:	7050 ± 80

The in situ wood, a stump (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-03)), was enclosed in peat above 10 cm of gyttja overlying deformed varved clays. Sample 91-VJ-354 was collected by J.J. Veillette on August 13, 1991, from the west shore of Lake Matagami near the junction with Allard River, Quebec (49°53.2′N, 77°45.0′W), at an elevation of 252 m. The sample was submitted by J.J. Veillette.

The sample (19.5 g wet weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 8.04 L of CO_2 gas. The age estimate is based on one count for 3840 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.788 ± 0.069, 2.231 ± 0.034, and 28.364 ± 0.176 cpm, respectively.

Comment (J.J. Veillette): The stump was covered by 1 m of peat. Accumulation of organic material at this site was initiated sometime after 7000 BP.

GSC-5344. Caps Aivirsiuvik

normalized age:	4140 ± 80
corrected age:	3740 ± 80
$\delta^{13}C$ =	+2.0‰
uncorrected age:	3700 ± 80

The marine shells (*Mytilus edulis*, identified by R.A. Daigneault) were enclosed in sand. Sample 91-DKA-151 was collected by R.A. Daigneault on July 13, 1991, from 8 km northeast of Caps Aivirsiuvik, Nouveau-Québec (61°43′46″N, 77°50′17″W), at an elevation of 36 m. The sample was submitted by R.A. Daigneault.

The sample (62.9 g dry weight) was treated with an acid leach to remove the outer 30%. The treated sample (30.0 g) yielded 6.66 L of CO_2 gas. The age estimate is based on two counts for 2200 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.424 ± 0.080, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

GSC-5310. Pointe de Sainte-Hélène (I)

normalized age:	7800 ± 110
corrected age:	7400 ± 110
$\delta^{13}C$ =	+2.1‰
uncorrected age:	7360 ± 110

The marine shells (*Hiatella arctica*, identified by R.A. Daigneault) were enclosed in sand. Sample 91-DKA-38 was collected by R.A. Daigneault on June 26, 1991, from 15 km east of Pointe de Sainte-Hélène, on the bank of the

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Kuugaq River, Ungava, Nouveau-Québec (62°08′25″N, 77°52′45″W), at an elevation of 98 m. The sample was submitted by R.A. Daigneault.

The sample (32.6 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (29.2 g) yielded 6.48 L of CO_2 gas. The age estimate is based on two counts for 2190 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.417 ± 0.071, 1.261 ± 0.033, and 18.546 ± 0.156 cpm, respectively.

GSC-5399. Pointe de Sainte-Hélène (II)

normalized age:	3980 ± 70
corrected age:	3580 ± 70
$\delta^{13}C$ =	+0.3‰
uncorrected age:	3580 ± 70

The marine shells (*Mytilus edulis*, identified by R.A. Daigneault) were enclosed in sand. Sample 91-DKA-23 was collected by R.A. Daigneault on July 24, 1991, from 3 km east-northeast of Pointe de Sainte-Hélène, Nouveau-Québec (62°10′54″N, 78°06′56″W), at an elevation of 32 m. The sample was submitted by R.A. Daigneault.

The sample (38.5 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (31.1 g) yielded 6.99 L of CO_2 gas. The age estimate is based on one count for 3895 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.918 ± 0.083, 2.185 ± 0.041, and 27.969 ± 0.203 cpm, respectively.

GSC-5322. Digges Islands

normalized age:	3170 ± 50
corrected age:	2770 ± 50
$\delta^{13}C$ =	+0.5‰
uncorrected age:	2760 ± 50

The marine shells (*Mytilis edulis*, identified by R.A. Daigneault) were from a surface collection on sand and gravel. Sample 91-DKA-227 was collected by R.A. Daigneault on July 29, 1991, from 3 km northwest of the mouth to 'Port de la Perriere', west Digges Island, Baffin Region, Nunavut, off the Quebec coast (62°34′38″N, 78°05′25″W), at an elevation of 22 m. The sample was submitted by R.A. Daigneault.

The sample (44.3 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (35.3 g) yielded 7.92 L of CO_2 gas. The age estimate is based on one count for 3600 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 20.013 ± 0.083, 2.107 ± 0.027, and 28.215 ± 0.129 cpm, respectively.

GSC-5341. Harricana Moraine

normalized age:	6450 ± 150
$\delta^{13}C$ =	-29.0‰
uncorrected age:	6520 ± 150

The peat was overlying clay east of the Harricana Moraine. Sample 91-VJ-423 was collected by J.J. Veillette and J. Pilon on October 16, 1991, along a power line, about 18 km northwest of the junction of a gravel road (along the Harricana Moraine) and the main paved road no. 61 to Matagami, Quebec (49°41′30″N, 78°18′00″W), at an elevation of 282 m. The sample was submitted by J.J. Veillette.

The sample (40.0 g wet weight) was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (7.4 g) yielded 1.76 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 2.51. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 8.051 ± 0.135, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

Comment (J.J. Veillette): The sample was collected with a Hiller sampler from the base of a 4 m peat layer that fills an iceberg track inscribed into the clay. The date is a minimum age for the onset of paludification at this site.

Ontario

***Figure 4.** Radiocarbon-dated sites in Ontario.*

GSC-5274. East Montreuil Lake

normalized age:	9870 ± 100
$\delta^{13}C$ =	-30.0‰
uncorrected age:	9950 ± 100

The lake sediment, a basal gyttja, was overlying a sandy clay gyttja and overlain by a banded brown gyttja. Sample AP-87-11 (1010.5–1015 cm) was collected by T.W. Anderson

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on August 30, 1987, from East Montreuil Lake, 3 km northwest of Mattawa, Ontario (46°20′N, 78°45′W), at an elevation of 208 m. The sample was submitted by T.W. Anderson.

The sample (235.0 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (77.0 g) yielded 5.86 L of CO_2 gas. The age estimate is based on one count for 3800 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.253 ± 0.049, 1.216 ± 0.026, and 18.122 ± 0.101 cpm, respectively.

GSC-5297. Strain Lake

normalized age: 9720 ± 120
$\delta^{13}C$ = -27.9‰
uncorrected age: 9760 ± 120

The lake sediment, basal gyttja, sample AP-88-8A (556.5–560 cm), was collected by T.W. Anderson on October 13, 1988, from about 1.5 km west of the junction between highways 69 and 69B, Strain Lake, northwest of Parry Sound, Ontario (45°21′33″N, 80°02′48″W), at an elevation of 195 m. The sample was submitted by T.W. Anderson.

The sample (162.1 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (43.1 g) yielded 4.19 L of CO_2 gas. The age estimate is based on one count for 3840 minutes in the 2 L counter with a mixing ratio of 1.08. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.500 ± 0.057, 1.261 ± 0.033, and 18.546 ± 0.156 cpm, respectively.

Hudson Bay Lowland

The Hudson Bay Lowland lies at the centre of the former Laurentide Ice Sheet, so the presence of seawater in Hudson Bay is a marker for a major reduction in glacial ice extent. Total D-alloisoleucine to L-isoleucine amino acid ratios (aIle/Ile) from in situ and transported *Hiatella arctica* marine shells and shell fragments from marine sediments, till, and other Quaternary sediments in the Hudson Bay Lowland cluster around values of 0.03, 0.07, 0.14, 0.18, and 0.22 (Thorleifson et al., 1992). Values of about 0.03 are derived from postglacial Tyrrell Sea shells. Values around 0.14 were obtained from the Prest Sea marine beds underlying till on the Abitibi and Severn rivers, and values of about 0.22 were obtained from the Bell Sea marine sediments underlying till on Kwetabohigan River, implying marine incursions of two ages. There is no stratigraphic evidence for additional marine incursions into Hudson Bay, and values around 0.07 and 0.18 were only obtained from tills. Thorleifson et al. (1992) therefore suggested that the clusters around 0.14 and 0.22 can be attributed to in situ or reworked marine sediments that were originally deposited on what is now land, whereas the 0.07 and 0.18 clusters would have been deposited offshore during the same marine incursions, respectively. The relatively high values of the former clusters were attributed to greater age, having been deposited early in a nonglacial episode prior to isostatic recovery, as well as higher temperatures experienced during a period of pre-Holocene subaerial exposure that would have been warmer than subglacial or submarine conditions. The shell fragments found in tills, typically transported from what is now offshore Hudson Bay, would be more likely to date to the end of a nonglacial episode, and would have a colder thermal history due to lack of pre-Holocene subaerial exposure.

Determination of the absolute age of these two pre-Holocene nonglacial episodes implied by the amino acid data remains unresolved. In the opinion of Thorleifson et al. (1992), no convincing finite radiocarbon determinations have been obtained from material underlying till in the region and, furthermore, the thermal history implies that the younger episode (0.14) relates to the last interglacial, oxygen isotope substage 5e. Thermoluminescence (TL) analyses, however, imply an age of about 75 ka for this event, oxygen isotope substage 5a, thereby inferring an oxygen isotope substage 5e age for the 0.22 cluster, by extrapolation. Until new dating methods are developed, further progress on this issue is unlikely to be made.

Between 1989 and 1991, however, an attempt was made to at least constrain the range of possibilities. In addition to a thermal history explanation for the 0.07 cluster, there remained the possibility that these values indicate a separate Middle Wisconsinan (oxygen isotope stage 3) marine incursion. Furthermore, these values from till are problematically low, some being 0.05, only slightly higher than Holocene values. Another possibility therefore was recognized, that the 0.07 ratios relate to a pre-Cochrane, post-Late-Wisconsinan marine incursion with an age of approximately 8 ka. This was regarded as a testable hypothesis, using accelerator mass spectrometry (AMS) dating of shell fragments known to have low amino acid ratios. L.H. Thorleifson and G.H. Miller conducted the analyses reported here, which were made possible by the availability of a collection of shell fragments from the upper till on the Attawapiskat River, as well as archived shells from marine sediments on Kwetabohigan River.

Attawapiskat River series

Marine shell fragments from till exposed in a riverbank section on the west bank of the Attawapiskat River, northwest of Highbank Lake, northern Ontario (52°21'N, 86°15'W), at an elevation of 180 m, were collected by L.H. Thorleifson on June 29, 1987. The section, 87TCA166, exhibited the following stratigraphy from top to bottom: 2.5 m of reddish till (5YR 4/4 to 10YR 5/4) overlying 2 m of brown till (10YR 5/4), which overlies 2 m of grey till (2.5Y 4/2), with about 2 m of the section covered in debris to river level. Reddish till, a rare occurrence in this area, contains numerous red carbonate rocks in the gravel fraction, and these are thought to be derived from Devonian rocks in Hudson Bay. The character of the till (red, calcareous, clay-rich, marine shell fragments) is attributed to long-distance transport from offshore central Hudson Bay, at the centre of an ice stream. Shell fragments

were collected from the till between 1.0 and 2.5 m depth (till sample levels E, F, and G) by visually scanning hand-broken blocks of till over a period of several hours.

Sample preparation at the University of Colorado Amino Acid Laboratory involved the following procedures. A total of 71 fragments were visually inspected and 21 of the largest fragments visually identified as probable *Hiatella arctica* were cleaned by mechanically removing an outer layer and leaching in acid. The fragments were then broken so that an aliquoit could be analyzed for amino acids by liquid chromatography, with a portion retained for radiocarbon analysis. The species identification was re-checked using concentrations and ratios of several amino acids, then the total alloisoleucine/ isoleucine ratio was calculated as a guide to relative age. Holocene shells analyzed in the same batch confirmed ratios of 0.03 to 0.04 for Holocene shells. Confirmed *Hiatella arctica* fragments from 87TCA166EFG yielded ratios of 0.04, 0.04, 0.05, 0.05, 0.06, 0.06, 0.07, 0.07, 0.07, 0.07, 0.07, 0.08, and 0.09. Three of these fragments, with ratios confirmed by repeat analyses of 0.05 (AAL-5996A), 0.04 (AAL-5996C), and 0.05 (AAL-5999C), were selected for radiocarbon dating and were given an acid leach to remove the outer 60% of the sample. These samples were submitted to the IsoTrace AMS Laboratory in sealed vials.

TO-1892. Attawapiskat River (I)

normalized age: 30 790 ± 230
corrected age: 30 380 ± 230

The marine shell fragment, sample 5996A (0.036 g dry weight; *Hiatella arctica*, identified by G.H. Miller), was enclosed in clay-rich till.

TO-1893. Attawapiskat River (II)

normalized age: 33 480 ± 310
corrected age: 33 070 ± 310

The marine shell fragment, sample 5996C (0.031 g dry weight; *Hiatella arctica*, identified by G.H. Miller), was enclosed in clay-rich till.

TO-1894. Attawapiskat River (III)

normalized age: 29 210 ± 220
corrected age: 28 800 ± 220

The marine shell fragment, sample 5999C (0.034 g dry weight; *Hiatella arctica*, identified by G.H. Miller), was enclosed in clay-rich till.

Comment (L.H. Thorleifson): These about 30 ka apparent ages seem to be an adequate basis to conclusively rule out the possibility of a post-Late Wisconsinan, pre-Cochrane, marine incursion. It therefore is confirmed that the shells with ratios of about 0.07 had a somewhat surprisingly cold thermal history, and an age of at least Middle Wisconsinan. The remaining possibilities are an actual Middle Wisconsinan age or sample contamination. A Middle Wisconsinan age is not supported because of a lack of finite radiocarbon dates on wood from the region. Analyses at the IsoTrace Laboratory done shortly before our analyses produced apparent ages >50 ka for optical-grade calcite. There was no reason to suspect contamination at the University of Colorado, so natural contamination from groundwater has to be considered.

As a follow-up, shells with higher amino acid ratios were radiocarbon dated. Ideally, the analyses would have utilized a reworked shell with a ratio so high that an age much greater than 50 ka could have been strongly suspected. If this shell had returned a finite age of about 30 ka, natural contamination would have been confidently proven. Unfortunately, the highest ratio from the collection was 0.09, so an old age could not conclusively be demonstrated. Regardless, it was therefore decided to run a test of two additional samples, using identical preparation procedures. A high-ratio shell from the original collection (0.08; sample 5997B) and another low-ratio shell from the original collection (0.05; sample 6001C) were dated. Similar apparent ages would have been supportive of contamination, whereas radiocarbon ages proportional to the amino acid ratios would have been supportive of an actual Middle Wisconsinan age.

TO-2501. Attawapiskat River (IV)

normalized age: 38 530 ± 460
corrected age: 38 120 ± 460

The marine shell fragment, sample 5997B (0.033 g dry weight; *Hiatella arctica*, identified by G.H. Miller), was enclosed in clay-rich till.

TO-2502. Attawapiskat River (V)

normalized age: 35 930 ± 370
corrected age: 35 520 ± 370

The marine shell fragment, sample 6001C (0.033 g dry weight; *Hiatella arctica*, identified by G.H. Miller), was enclosed in clay-rich till.

Comment (L.H. Thorleifson): The ^{14}C ages are, broadly, proportional to their amino acid ratios. The shell with a ratio of 0.08 yielded an age (38 ka) older than those obtained from shells with ratios of about 0.05 (30 ka, 33 ka, 29 ka, 36 ka). This provides supportive, although not particularly convincing, evidence for an actual Middle Wisconsinan age. On the other hand, it is noted that the values in the second batch are all older than those in the first batch, results within the first batch are inversely proportional to age, and a discrepancy of about 5 ka exists between determinations on shells with the same ratio. The possibility of variable laboratory contamination therefore has to be considered. To enhance our confidence, one of the low-ratio shells was re-analyzed at the Arizona AMS dating facility.

AA-7564. Attawapiskat River (VI)

>39 260

The marine shell fragment, sample 5996A (*Hiatella arctica*, identified by G.H. Miller), was enclosed in clay-rich till.

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Comment (L.H. Thorleifson): Sample 5996A was a single shell fragment that yielded ages of 30 ka (TO-1892) and >39 ka (AA-7564) in different AMS facilities and thus casts doubt on the younger ages for these shells.

Because a very high-ratio shell was not available in the Attawapiskat collection, samples regarded as likely being the oldest available shells from the region were analyzed. This required using marine shells collected by R.G. Skinner from the Bell Sea type section on the Kwetabohigan River. The estimated age from alloisoleucine/isoleucine ratios of about 0.22 suggests an age of 130 ka, possibly 500 ka. Shells from the previously radiometrically dated collection yielded results of 38 200 ± 2000 for the outer fraction (GSC-1475 OF) and >37 000 for the inner fraction (GSC-1475 IF; Skinner, 1973; Blake, 1988). These results suggest in situ contamination, given that a finite age was obtained from an analysis that included the outer fraction of the shells. It was acknowledged that the test would not be conclusive, given that the two sites, Kwetabohigan River and Attawapiskat River, would likely have different environmental conditions.

Kwetabohigan River series

Marine shells from marine sediments underlying till on the south bank of the Kwetabohigan River, northern Ontario (51°08'N, 82°07'W), at an elevation of 90 m, were collected as sample SJA 70-67 by R.G. Skinner at station 61 on July 6, 1970.

TO-2503. Kwetabohigan River (I)

normalized age: 48 260 ± 1090
corrected age: 47 850 ± 1090

The marine shell fragment, sample 6520A (0.040 g dry weight), was enclosed in marine silt and clay.

TO-2504. Kwetabohigan River (II)

The marine shell fragment, sample 6520D (0.034 g dry weight), was enclosed in marine silt and clay. This sample was lost during sample preparation at IsoTrace Laboratory.

Comment (L.H. Thorleifson): The finite apparent age of about 48 ka could be attributed to in situ contamination, on the basis of previous radiometric dating, and the much older probable age based on amino acid analysis. If an apparent age in the 30s had been obtained, doubt would have been cast on the Attawapiskat results, and uniform contamination across the region would have been suspected. The apparent age is, however, much older than the apparent ages obtained on Attawapiskat River samples. This could be taken as an indication that the Attawapiskat River shells are indeed of middle Wisconsinan age, but, unfortunately, these shells are from a different site and therefore may have had a different environmental history. To enhance our confidence in the data, a high-ratio shell from another site, on the Abitibi River, was submitted to the Arizona AMS dating facility.

Abitibi River

AA-7563. Abitibi River

>42 900

The marine shell fragment, sample 6522A, was enclosed in marine silt and clay at the type locality of the Prest Sea sediments on the Abitibi River (same site as GSC-1535, Skinner, 1973; Thorleifson et al., 1992).

Comment (L.H. Thorleifson): The two dates on 'old' shells (TO-2503 (48 ka) and AA-7563 (>43 ka)) are not in conflict, but caution regarding finite determinations is reinforced.

General comment (L.H. Thorleifson): The analyses confirmed that no pre-Cochrane, post-Late Wisconsinan marine incursion is indicated by marine shells in till from the Hudson Bay Lowland. This implies surprisingly cold conditions through the Late Wisconsinan and the preceding time for shells in till that yield ratios of as low as 0.05, only slightly higher than values of 0.03 to 0.04 in Holocene shells.

Conflicting data were obtained for the absolute age of what seemed to be the youngest pre-Holocene shells in the region, with data from one laboratory providing supportive, albeit suspicious, evidence for an age of about 30 ka, and one date from another laboratory suggesting > 39 ka. The matter is considered unresolved, although it should be mentioned that similar ages have been obtained by TL in Manitoba (Berger and Nielsen, 1991; Thorleifson et al., 1992). The lack of finite ages on wood remains a benchmark consideration against the possibility of Middle Wisconsinan deglaciation of the Hudson Bay Lowland.

WESTERN CANADA

Alberta

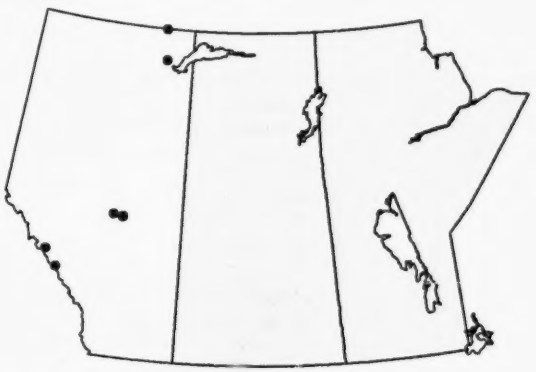

Figure 5. *Radiocarbon-dated sites in Alberta.*

GSC-5884. Peace River

normalized age: 8720 ± 80
$\delta^{13}C$ = -24.4‰
uncorrected age: 8710 ± 80

The wood, the outermost 10 to 15 rings of a *Picea* log (identified by H. Jetté (unpublished GSC Wood Report No. 94-99)), was enclosed in sand. Sample 94-BJB-0098 was collected by J. Bednarski on August 6, 1994, from the north cutbank of the Peace River, about 11 km southeast of Carlson Landing, Wood Buffalo National Park, Alberta (58°57′N, 111°40′W), at an elevation of 214 m. The sample was submitted by J. Bednarski.

The sample (10.1 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.1 g) yielded 8.06 L of CO_2 gas. The age estimate is based on one count for 3545 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.628 ± 0.067, 2.233 ± 0.034, and 28.468 ± 0.135 cpm, respectively.

Comment (J. Bednarski): The age of the log is in agreement with the lake-level curve constructed by Lemmen et al. (1994) for Glacial Lake McConnell at about 215 m above sea level (Bednarski, 1999).

GSC-5887. Fort Smith Settlement

normalized age: 8070 ± 100
$\delta^{13}C$ = -27.6‰
uncorrected age: 8110 ± 100

The wood twigs and fragments (unidentifiable according to H. Jetté (unpublished GSC Wood Report No. 95-18)) were enclosed in sand. Sample 94-BJB-0103 was collected by J. Bednarski on August 11, 1994, from 300 m south of the Northwest Territories border adjacent to Fort Smith Settlement, Alberta (59°59′N, 111°50′W), at an elevation of 210 m. The sample was submitted by J. Bednarski.

The sample (6.0 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (5.2 g) yielded 4.37 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.683 ± 0.068, 1.212 ± 0.025, and 18.348 ± 0.104 cpm, respectively.

Comment (J. Bednarski): This date falls on the lake-level curve published by Lemmen et al. (1994), therefore it is in good correspondence for the age of the 210 m a.s.l. level of Glacial Lake McConnell. GSC-5884 (above) dated at 8.7 ka BP, from a site 100 km south, also plots on the lake-level curve (Bednarski, 1999).

Edmonton series

A series of wood samples were collected from gravel deposits in the Edmonton area, Alberta. The samples were submitted by R.R. Young.

GSC-5367. Consolidated Pit 48 (I)

> 39 000
$\delta^{13}C$ = -26.0‰

GSC-5367 was collected from Consolidated Pit 48, Strathcona County, 5 km east of Edmonton, Alberta (53°39′N, 113°17′W), at an elevation of 612 m, by R.R. Young on June 25, 1989.

The wood, sample QP-77 (86.3 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-13)), enclosed in sand and gravel, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (15.6 g) yielded 8.12 L of CO_2 gas. The age estimate is based on one count for 3700 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.025 ± 0.043, 2.305 ± 0.035, and 28.206 ± 0.135 cpm, respectively.

GSC-5359. Consolidated Pit 48 (II)

normalized age: 32 500 ± 900
$\delta^{13}C$ = -25.6‰
uncorrected age: 32 500 ± 900

GSC-5359 was collected from Consolidated Pit 48, Strathcona County, 5 km east of Edmonton, Alberta (53°39′N, 113°17′W), at an elevation of 612 m, by R.R. Young on June 25, 1989.

The wood, sample QP-76 (42.0 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-09)), enclosed in sand and gravel, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (12.4 g) yielded 4.27 L of CO_2 gas. The age estimate is based on one count for 3750 minutes in the 2 L counter with a mixing ratio of 1.06. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.317 ± 0.035, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

GSC-5392. Riverview

> 39 000
$\delta^{13}C$ = -26.9‰

GSC-5392 was collected from Standard General Riverview pit, city of Edmonton, Alberta (53°37′N, 113°18′W), at an elevation of 617 m, by R.R. Young in July 1991.

The wood, sample QP-78 (10.9 g dry weight; *Picea* or *Larix*, identified by H. Jetté (unpublished GSC Wood Report No. 92-25)), enclosed in sand and gravel, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.6 g) yielded 8.24 L of CO_2 gas. The age estimate is based on one count for 3375 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.055 ± 0.039, 2.234 ± 0.029, and 28.421 ± 0.132 cpm, respectively.

GSC-5424. Villeneuve

> 39 000
$\delta^{13}C$ = -24.5‰

GSC-5424 was collected from 2 km north of the town of Villeneuve, municipal district of Sturgeon, Alberta (53°40′20″N, 113°48′30″W), at an elevation of 662 m, by R.R. Young on August 18, 1989.

The wood, sample QP-79 (21 m below surface; 14.4 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-49)), enclosed in sand and gravel above bedrock, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 8.13 L of CO_2 gas. The age estimate is based on one count for 3400 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.060 ± 0.036, 2.106 ± 0.025, and 28.293 ± 0.128 cpm, respectively.

Comment (R.R. Young): These four dates relate to the study of fossils and subtill gravel deposits in the Edmonton region. Earlier dates, stratigraphy, and fossils are reported *in* Young et al. (1994) and Burns and Young (1994).

GSC-5356. Peyto Lake

normalized age: 2900 ± 70
$\delta^{13}C$ = -24.3‰
uncorrected age: 2890 ± 70

The wood (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-06)) was enclosed in till and outwash. Sample P91-BNP was collected by G. Holdsworth on September 15, 1990, from about 3 km south of Peyto Lake delta, 5 km from the Banff-Jasper Highway, and 30 km northwest of Lake Louise, Alberta (51°41′N, 116°32.5′W), at an elevation of 2135 m. The sample was submitted by G. Holdsworth.

The sample (9.8 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (9.0 g) yielded 7.78 L of CO_2 gas. The age estimate is based on two counts for 1955 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.636 ± 0.134, 2.215 ± 0.033, and 28.129 ± 0.131 cpm, respectively.

Comment (G. Holdsworth): The excess of dated sample was donated to Banff National Park for their collections.

Jasper-Banff highway series

A series of wood samples from south of the Jasper-Banff highway near the Icefields Chalet and Jasper National Park headquarters, Alberta, were collected by G. Holdsworth on September 5, 1993. The sample was submitted by G. Holdsworth.

GSC-5681. Jasper-Banff highway (I)

normalized age: 160 ± 60
$\delta^{13}C$ = -23.3‰
uncorrected age: 140 ± 60

This site is 800 m south of the Jasper-Banff highway (52°12.8′N, 117°13.4′W) at an elevation of 2000 m. The wood, sample ATG 93-2 (12.9 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 94-10)), enclosed in till, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 7.83 L of CO_2 gas. The age estimate is based on one count for 1080 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.827 ± 0.170, 2.235 ± 0.033, and 28.299 ± 0.131 cpm, respectively.

GSC-5704. Jasper-Banff highway (II)

normalized age: 160 ± 60
$\delta^{13}C$ = -22.3‰
uncorrected age: 120 ± 60

This site is 800 m south of the Jasper-Banff highway (52°12.8′N, 117°13.4′W) at an elevation of 2000 m. The wood, sample ATG 93-3 (7.4 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 94-67)), enclosed in till, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (6.9 g) yielded 6.78 L of CO_2 gas. The age estimate is based on two counts for 1950 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 18.116 ± 0.104, 1.199 ± 0.028, and 18.393 ± 0.105 cpm, respectively.

Comment (G. Holdsworth): A date of AD 1790 (AD 1747 or 1803 cal.) places a lower limit on the Little Ice Age maximum advance. The wood could have been reworked by the earlier advance and transported to its present position by the last advance, which was the most expansive.

GSC-5716. Jasper-Banff highway (III)

normalized age: 60 ± 50
$\delta^{13}C$ = -21.8‰
uncorrected age: 10 ± 50

This site is 700 m south of the Jasper-Banff highway (52°12.7′N, 117°13.7′W) at an elevation of 1950 m. The wood, sample ATG 93-4 (13.5 g dry weight; *Abies*, identified by H. Jetté (unpublished GSC Wood Report No. 94-64)), enclosed in till, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 7.49 L of CO_2 gas. The age estimate is based on one count for 2200 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 28.056 ± 0.121, 2.258 ± 0.029, and 28.094 ± 0.130 cpm, respectively.

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Comment (G. Holdsworth): This essentially modern sample does not add to our knowledge of glacier movements.

GSC-5676. Athabasca Glacier

modern
$\delta^{13}C$ = -24.7‰

The wood (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 94-07)) was enclosed in till or outwash. Sample ATG 93-1 was collected by G. Holdsworth on September 5, 1993, from the east side of the Athabasca Glacier forefield, less than 100 m from the ice front, 1.5 km south of the Jasper-Banff highway, Jasper National Park, Alberta (52°12.5′N, 117°13.75′W), at an elevation of 1980 m. The sample was submitted by G. Holdsworth.

The sample (11.6 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (9.0 g) yielded 7.88 L of CO_2 gas. The age estimate is based on one count for 1070 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 34.021 ± 0.187, 2.235 ± 0.033, and 28.299 ± 0.131 cpm, respectively.

Comment (G. Holdsworth): The sample must have been transported by humans.

NORTHERN CANADA (MAINLAND)

Northwest Territories

***Figure 6.** Radiocarbon-dated sites on the mainland Northwest Territories.*

GSC-5343. Needle Lake

normalized age: 9260 ± 140
$\delta^{13}C$ = -28.0‰
uncorrected age: 9310 ± 140

The lake sediment was overlying glaciolacustine clay. Sample PL-91-26 (90-LJA-NLCL-base) was collected by D.S. Lemmen on March 17, 1990, from Needle Lake, Wood Buffalo National Park, District of Mackenzie, Northwest Territories (60°18′N, 114°26′W), at an elevation of about 273 m. The sample was submitted by R.J. Mott.

The sample (29.0 g wet weight) was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (13.5 g) yielded 2.12 L of CO_2 gas. The age estimate is based on one count for 3700 minutes in the 2 L counter with a mixing ratio of 2.10. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.684 ± 0.087, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

Comments (R.J. Mott): An inappropriate sampling method used to obtain this core makes most of the core unreliable for pollen work or dating. However, the sampling appears to have penetrated 496 cm of organic lake sediment overlying clay of possible glaciolacustrine origin. The clay near the contact with the organic sediments is somewhat gritty due to some fine sand or silt content. The basal sediment in one core increment appeared to be undisturbed and suitable for dating. The age obtained for the 493–496 cm increment below the sediment-water interface is within the estimated age range for the sample. However, an analysis for carbon indicated a slight carbonate content in the sediment raising the possibility that the age may be somewhat too old due to hard-water error. Except for the basal organic sediments, pollen analysis of the core was not warranted because of the disturbed nature of most of the sediment.

GSC-5201. 'Hornaday' Lake

normalized age: 2150 ± 80
$\delta^{13}C$ = -27.9‰
uncorrected age: 2200 ± 80

The peat, sample HP-1 (5-10 cm), enclosed in peat, was collected by S.C. Zoltai on September 9, 1990, from the east shore of 'Hornaday' Lake (unofficial name), District of Mackenzie, Northwest Territories (68°43′N, 120°38′W), at an elevation of 520 m. The sample was submitted by S.C. Zoltai.

The sample (80.8 g wet weight) was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (30.5 g) yielded 5.01 L of CO_2 gas. The age estimate is based on one count for 3370 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.864 ± 0.071, 1.087 ± 0.025, and 18.225 ± 0.161 cpm, respectively.

Comments (S.C. Zoltai): The sample date indicates the approximate time of the cessation of peat deposition as the polygon trench deepened and the centre of the polygon was drained. Some loss of surface peat may have occurred through oxidation or wind erosion.

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Norman Wells series

A series of wood and peat (forest litter and organic fragments) samples from 80 km west of Norman Wells, near Mountain River, Northwest Territories (65°14′N, 128°33′W), at an elevation of 400 m, were collected by C. Bégin (GSC-5332 collected by C. Bégin and Y. Michaud) on August 17, 1991 (GSC-5348 collected on August 23, 1991; GSC-5358 collected on August 26, 1991). All the samples were submitted by C. Bégin.

GSC-5332. Norman Wells (I)

normalized age: 910 ± 60
$\delta^{13}C$ = -24.7‰
uncorrected age: 900 ± 60

The wood, sample E-12-8 (18.0 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 91-88)), was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.7 g) yielded 8.17 L of CO_2 gas. The age estimate is based on two counts for 2090 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 25.354 ± 0.120, 2.231 ± 0.034, and 28.364 ± 0.176 cpm, respectively.

GSC-5365. Norman Wells (II)

normalized age: 890 ± 50
$\delta^{13}C$ = -26.6‰
uncorrected age: 910 ± 50

The wood, sample D-12-4 (11.0 g dry weight; *Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 92-22)), was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 8.22 L of CO_2 gas. The age estimate is based on two counts for 2080 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 25.106 ± 0.119, 2.215 ± 0.033, and 28.129 ± 0.131 cpm, respectively.

GSC-5348. Norman Wells (III)

normalized age: 1850 ± 100
$\delta^{13}C$ = -24.6‰
uncorrected age: 1840 ± 100

The peat (organic fragments), sample H-12-10-A (95.2 g wet weight), enclosed in sand, was treated with cold base, hot acid (very calcareous), and distilled water rinses. The treated sample (67.3 g) yielded 1.92 L of CO_2 gas. The age estimate is based on two counts for 1845 minutes in the 2 L counter with a mixing ratio of 2.30. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.412 ± 0.160, 1.238 ± 0.028, and 18.133 ± 0.104 cpm, respectively.

GSC-5358. Norman Wells (IV)

normalized age: 2060 ± 70
$\delta^{13}C$ = -25.7‰
uncorrected age: 2080 ± 70

The peat (forest litter), sample E-13-15-A (61.9 g dry weight), enclosed in sand, was treated with cold base, hot acid (slightly calcareous), and distilled water rinses. The treated sample (43.7 g) yielded 4.35 L of CO_2 gas. The age estimate is based on one count for 2310 minutes in the 2 L counter with a mixing ratio of 1.02. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.004 ± 0.087, 1.238 ± 0.028, and 18.133 ± 0.104 cpm, respectively.

GSC-5655. Hume River

normalized age: 3490 ± 60
$\delta^{13}C$= -25.8‰
uncorrected age: 3510 ± 60

The wood (*Populus*, identified by H. Jetté (unpublished GSC Wood Report No. 94-01)) was enclosed in organic-rich, silty, very fine sand. Sample HR-93-1 was collected by G.R. Brooks on July 24, 1993, from along the western bank of the Mackenzie River, 150 m upstream of the confluence with the Hume River, 36.5 km south of Fort Good Hope, District of Mackenzie, Northwest Territories (66°01.2′N, 129°08.7′W), at an elevation of about 35 m. The sample was submitted by G.R. Brooks.

The sample (9.8 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (4.9 g) yielded 5.11 L of CO_2 gas. The age estimate is based on one count for 3800 minutes in the 5 L counter with a mixing ratio of 1.17. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 18.392 ± 0.087, 2.282 ± 0.028, and 28.460 ± 0.130 cpm, respectively.

Comment (G.R. Brooks): Organic-rich, interbedded silt and sand deposits are exposed between 6 to 17 m below the surface of the 19 m high river bank along the western side of the Mackenzie River immediately upstream of the Hume River confluence. These deposits are believed to represent overbank sedimentation arising from floods of the Mackenzie and Hume rivers. The wood sample was situated 7.4 m below the surface of the bank. It had been reworked and represents a maximum age for the upper 7.4 m of the river bank.

GSC-5256. Eskimo Lakes Peninsula

normalized age: 7970 ± 90
$\delta^{13}C$ = -24.4‰
uncorrected age: 7960 ± 90

The wood (*Picea*, identified by H. Jetté (unpublished GSC Wood Report No. 91-40)), sample EL-1 (2.5 m), was collected by C. Bégin and Y. Michaud on August 9, 1990, from

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5 km north of Inuvik, Eskimo Lakes Peninsula, District of Mackenzie, Northwest Territories (68°50′N, 133°26′W), at an elevation of 50 m; it was submitted by C. Bégin.

The sample (20.1 g dry weight) was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (9.1 g) yielded 8.56 L of CO_2 gas. The age estimate is based on two counts for 1995 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 10.461 ± 0.086, 2.186 ± 0.033, and 28.173 ± 0.146 cpm, respectively.

Taglu Island series

A series of organic samples from the extreme south end of Taglu Island in the modern Mackenzie Delta, 75 km west of Tuktoyaktuk, District of Mackenzie, Northwest Territories (69°22′N, 134°57′W), at an elevation of 1 m, were collected by L. Dyke on August 9, 1991. The samples were submitted by L. Dyke.

GSC-5362. Taglu Island (I)

normalized age:	700 ± 80
$\delta^{13}C$ =	-26.8‰
uncorrected age:	720 ± 80

The organic matter, sample 91-DW-1 (140–145 cm; 16.6 g wet weight), enclosed in silt and clay, was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.5 g) yielded 3.31 L of CO_2 gas. The age estimate is based on two counts for 2115 minutes in the 2 L counter with a mixing ratio of 1.32. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 16.504 ± 0.111, 1.246 ± 0.024, and 18.063 ± 0.123 cpm, respectively.

GSC-5387. Taglu Island (II)

normalized age:	210 ± 90
$\delta^{13}C$ =	-25.3‰
uncorrected age:	220 ± 90

The organic matter sample, 91-DW-2 (190–195 cm; 8.6 g wet weight), enclosed in silt and clay, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (2.4 g) yielded 1.90 L of CO_2 gas. The age estimate is based on one count for 2400 minutes in the 2 L counter with a mixing ratio of 2.31. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.577 ± 0.151, 1.246 ± 0.024, and 18.063 ± 0.123 cpm, respectively.

Comments (L. Dyke): GSC-5387 and GSC-5362 both consist of roots from 1 or 2 cm thick organic layers beneath an alluvial island at the front of the Mackenzie Delta. Twig detritus was also present in the samples and may be the cause of the reversal in ages from what would be expected by the stratigraphic order. Assuming that contamination by reworked material made GSC-5362 anomalously old, the determined age of 210 ± 90 for the lower sample (GSC-5387) is probably close to being correct. It can be used to estimate an approximate aggradation rate for the island surface.

NORTHERN CANADA, ARCTIC ARCHIPELAGO

Northwest Territories

Figure 7. *Radiocarbon-dated sites in the Arctic Archipelago, Northwest Territories.*

Banks Island

Several small unnamed lakes on Banks Island were cored for dating and paleoecological studies. Basal dates from four of these sites were reported in Lowdon and Blake (1980) and were included in the surficial geology report on the area (Vincent, 1983). Subsequently, sediments from three of these lakes were studied palynologically and further dates were obtained to aid in outlining the chronology of the vegetational history. These lakes are located in three different terranes related to the surficial geology of the island (Vincent, 1983). One lake occupies a small depression in Baker Till of the Thomsen Glaciation in north central Banks Island near Shoran Lake. The second is in a kettle in ice-contact deposits associated with Carpenter Till of the Amundsen Glaciation about 40 km southeast of Sachs Harbour on the southwest coast of Banks Island. The third occupies a small kettle in an upland area in Jesse Till of the Amundsen Glaciation in southeastern Banks Island about 18.5 km west of Stewart Point. All cores were collected with a modified Livingstone corer by R.J. Mott in July 1974. The samples were submitted by R.J. Mott. Pollen analyses were conducted on contract (University of Ottawa) to C.X. Wang and M.A. Geurts. Results were published by Gajewski et al. (2000).

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Shoran Lake series

A small unnamed lake (site 74-MS-15) located 2 km east of Shoran Lake and 5 km west of Thomsen River (73°32'N, 120°13'W), at an elevation of 120 m, had a maximum water depth of 8.5 m at the coring location. The core reached 305 cm below the mud-water interface. Below the interface a total of 266 cm of black and mottled or banded black to dark grey silty gyttja becomes less organic with depth, contains shells, and is slightly calcareous below about 220 cm. Below 266 cm, dark grey to black calcareous silty clay with abundant moss extends to 297 cm. Calcareous, dark brown-grey, stiff silt to fine sand with pebbles (diamicton) occurs to the base of the core at 305 cm. The core was collected by R.J. Mott on July 20, 1974. The samples were submitted by R.J. Mott.

GSC-5187. Shoran Lake (I)

normalized age:	3020 ± 120
$\delta^{13}C$ =	-28.6‰
uncorrected age:	3080 ± 120

The organic lake sediment (55–60 cm; 51.2 g wet weight), enclosed in lake sediment, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample yielded 1.95 L of CO_2 gas. The age estimate is based on two counts for 1850 minutes in the 2 L counter with a mixing ratio of 2.27. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.417 ± 0.147, 1.087 ± 0.025, and 18.225 ± 0.161 cpm, respectively.

GSC-5183. Shoran Lake (II)

normalized age:	5060 ± 110
$\delta^{13}C$ =	-28.5‰
uncorrected age:	5120 ± 110

The organic lake sediment (93–98 cm; 102.3 g wet weight), enclosed in lake sediment, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (18.0 g) yielded 2.13 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 2.07. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 9.736 ± 0.119, 1.057 ± 0.020, and 18.411 ± 0.103 cpm, respectively.

GSC-5177. Shoran Lake (III)

normalized age:	9170 ± 160
$\delta^{13}C$ =	-28.4‰
uncorrected age:	9230 ± 160

The organic lake sediment (192–196 cm; 142.4 g wet weight), enclosed in lake sediment, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (33.8 g) yielded 2.86 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 1.55. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.836 ± 0.102, 1.057 ± 0.020, and 18.411 ± 0.103 cpm, respectively.

GSC-2673. Shoran Lake (IV)

normalized age:	10 200 ± 130
$\delta^{13}C$ =	-26.2‰
uncorrected age:	10 200 ± 130

The moss fragments (275–280 cm; 14.1 g dry weight; *Calliergon giganteum, Drepanocladus aduncus, Meesia triquetra,* and *Scorpidium scorpioides*), enclosed in clay, were treated with hot acid and distilled water rinses. The base treatment was omitted. The treated sample (9.6 g) yielded 3.091 L of CO_2 gas. The age estimate is based on one count for 3000 minutes in the 2 L counter with a mixing ratio of 1.85. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.989 ± 0.069, 1.294 ± 0.020, and 17.820 ± 0.098 cpm, respectively.

Comments (R.J. Mott): Moss fragments from the moss layer at 280–275 cm depth were used for dating. Mosses identified include some submerged forms (J.A. Janssens, unpublished Bryological Reports JJ282 and JJ283). Since the enclosing sediment was calcareous, the date of 10 200 ± 130 BP may possibly be somewhat anomalous due to hard-water error (MacDonald et al., 1987). Bulk organic sediment was used for the other three dates. GSC-2673 provides a minimum age for the beginning of organic deposition. Pollen analysis of the core shows that tundra vegetation similar to present-day vegetation has prevailed throughout the time interval represented. Some fluctuations in the abundance of grasses and sedges may indicate minor changes in the extant climate. GSC-5177 dates the change in dominance from grass pollen to sedge pollen, GSC-5183 marks the return to dominance of grass pollen, and GSC-5187 shows an increase once again in sedge pollen (Gajewski et al., 2000).

Sachs Harbour series

A lake (site 74-MS-11) in a moraine along the southwest coast about 40 km southeast of Sachs Harbour (71°45'N, 124°16'W), is at an elevation of about 30 m, with a maximum water depth of 8.0 m. Mottled black to dark grey clayey lake sediment with some mossy layers was encountered to 252 cm depth below the mud-water interface. This overlies, with a gradational contact, brownish-grey clay with some moss fragments to 265 cm depth. Below is brownish-grey, clayey silt with some pebbles (diamicton). A core was collected by R.J. Mott on July 23, 1974. The samples were submitted by R.J. Mott.

GSC-5198. Sachs Harbour (I)

normalized age:	2960 ± 150
$\delta^{13}C$ =	-27.7‰
uncorrected age:	3010 ± 150

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The organic lake sediment (85–92 cm; 112.0 g wet weight), enclosed in lake sediment, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (22.6 g) yielded 2.39 L of CO_2 gas. The age estimate is based on two counts for 2015 minutes in the 2 L counter with a mixing ratio of 1.86. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.568 ± 0.189, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

GSC-5286. Sachs Harbour (II)

normalized age:	8820 ± 260
$\delta^{13}C$ =	-24.2‰
uncorrected age:	8800 ± 260

The organic lake sediment (197–206 cm; 150.7 g wet weight), enclosed in lake sediment, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (50.4 g) yielded 1.53 L of CO_2 gas. The age estimate is based on two counts for 1910 minutes in the 2 L counter with a mixing ratio of 2.91. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.058 ± 0.191, 1.216 ± 0.026, 18.122 ± 0.101 cpm, respectively.

GSC-2260. Sachs Harbour (III)

normalized age:	9840 ± 340
$\delta^{13}C$ =	-27.0‰
uncorrected age:	9870 ± 340

The lake sediment, basal organic material (246–252 cm; 8.5 g wet weight), was treated with hot acid and distilled water rinses. The base treatment was omitted. The treated sample (34.6 g) yielded 0.778 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 2 L counter with a mixing ratio of 6.46. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.615 ± 0.234, 1.034 ± 0.021, and 19.187 ± 0.101 cpm, respectively.

Comments (R.J. Mott): Bulk samples were used for all dating. The pollen profile for this site, like the other two sites described above, is dominated by pollen indicative of tundra-type vegetation. However, this site shows more birch pollen, suggestive of more shrubs on the landscape, and more alder and slightly more spruce pollen, indicative of closer proximity to these taxa that occur to the south on the mainland. GSC-2260 provides an age for the beginning of organic deposition. GSC-5286 dates the decline in sedge pollen seen at the other sites, that is here coincident with an increase in alder pollen. GSC-5198 gives an age for a decline in alder and the increase in grass pollen seen in the other profiles (Gajewski et al., 2000).

Stewart Point series

A small unnamed lake (site 74-MS-12) is located in an upland area about 18.5 km west of Stewart Point (72°22′N, 119°50′W) at an elevation of about 220 m. Maximum water depth at the core site was 15 m. The core showed 85 cm of noncalcareous, greenish-grey silty gyttja overlying and grading into black silty gyttja to 106 cm depth. This overlies, with a sharp contact, brownish-grey calcareous clay with some organic content, and black and grey-brown calcareous silty clay to 122 cm depth. Beneath is greyish-black to grey silty clay with layers of moss fragments to 159 cm depth overlying dark grey-black, highly calcareous, pebbly silty clay (diamicton). The core was collected by R.J. Mott on July 26, 1974. The samples were submitted by R.J. Mott.

GSC-5208. Stewart Point (I)

normalized age:	3860 ± 130
$\delta^{13}C$ =	-28.5‰
uncorrected age:	3920 ± 130

The organic lake sediment (49–55 cm; 82.6 g wet weight), enclosed in lake sediment, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (10.0 g) yielded 1.83 L of CO_2 gas. The age estimate is based on one count for 2200 minutes in the 2 L counter with a mixing ratio of 2.38. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.221 ± 0.137, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

GSC-5304. Stewart Point (II)

normalized age:	7790 ± 130
$\delta^{13}C$ =	-28.0‰
uncorrected age:	7840 ± 130

The organic lake sediment (103–105 cm; 93.0 g wet weight), enclosed in lake sediment, was treated with hot acid (noncalcareous) and distilled water rinses. The base treatment was omitted. The treated sample (28.2 g) yielded 2.70 L of CO_2 gas. The age estimate is based on two counts for 2085 minutes in the 2 L counter with a mixing ratio of 1.64. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.886 ± 0.096, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

GSC-2654. Stewart Point (III)

normalized age:	9080 ± 160
$\delta^{13}C$ =	-32.8‰
uncorrected age:	9210 ± 160

The organic material (123–153 cm; 3.1 g dry weight; *Drepanocladus badius*), enclosed in clay, was treated with hot acid and distilled water rinses. The base treatment was omitted. The treated sample (2.2 g) yielded 1.465 L of CO_2 gas. The age estimate is based on one count for 3000 minutes in the 2 L counter with a mixing ratio of 3.29. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.159 ± 0.133, 1.378 ± 0.020, and 19.376 ± 0.102 cpm, respectively.

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Comments (R.J. Mott): The moss fragments, recovered from the calcareous silty clay between 123 and 153 cm depth, were used for dating. Although the moss in this core was identified as *Drepanocladus badius*, which is not a moss of permanently submerged habitats (J.A Janssens, unpublished Bryological Report JJ281), the date may be somewhat anomalous due to hard-water error as mentioned above. Bulk organic sediment was used for the other two age determinations. GSC-2654 dates the beginning of organic deposition at the site. GSC-5304 dates a lithological change to greater organic deposition, whereas GSC-5208 dates a pollen change to greater abundance of grass pollen over sedge. Sedges, grasses, and birch pollen dominate the pollen profile for this site indicating the presence of tundra-type vegetation cover-age of the area throughout the time interval involved. The somewhat higher values for birch and willow pollen may indicate a greater representation of these shrubs in or near the area than at the interior site noted above (Gajewski et al., 2000).

Melville Island

Winter Harbour series

A series of marine shell samples from 0.1 to 0.5 km inland from the head of the bay between Fife and Braithwaite points, Winter Harbour, Melville Island, District of Franklin, Northwest Territories (74°48.25′N, 110°28′W), at an elevation of 1.2 m, were collected by D.A. Hodgson and J.S. Vincent on August 3, 1980. The samples were submitted by D.A. Hodgson.

GSC-5225. Winter Harbour (I)

uncorrected age: 6840 ± 150

The marine shell (a single paired valve), sample HCA 80 3-8-3 (11.3 g dry weight; *Mya truncata*, identified by D.A. Hodgson), enclosed in sand and gravel, was treated with an acid leach to remove the outer 10% of the sample. The treated sample (10.6 g) yielded 2.29 L of CO_2 gas. The age estimate is based on two counts for 2120 minutes in the 2 L counter with a mixing ratio of 1.93. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.852 ± 0.133, 1.110 ± 0.028, and 18.388 ± 0.133 cpm, respectively.

Comment (D.A. Hodgson): The single paired valve at an elevation of 1.2 m, buried by 30 cm of littoral or deltaic sand, provides a maximum age for the 1.5 m sea level. The date is older than expected, so the sea level was probably much higher and/or the shell was redeposited, cf. GSC-663 (Hodgson et al., 1984, Table 2; Blake, 1984).

GSC-5235. Winter Harbour (II)

normalized age: 9140 ± 140
corrected age: 8740 ± 140
$\delta^{13}C$ = +1.9‰
uncorrected age: 8710 ± 140

The marine shell (a single paired valve), sample HCA 80 3-8-2 (13.9 g dry weight; *Mya truncata*, identified by D.A. Hodgson), enclosed in sand, was treated with an acid leach to remove the outer 10% of the sample. The treated sample (13.2 g) yielded 2.84 L of CO_2 gas. The age estimate is based on two counts for 2230 minutes in the 2 L counter with a mixing ratio of 1.58. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.218 ± 0.087, 1.110 ± 0.028, and 18.388 ± 0.133 cpm, respectively.

Comment (D.A. Hodgson): The single paired valve at an elevation of 7.5 m, buried by 2 m of littoral or deltaic sand, provides a maximum age for the 9.5 m sea level, in agreement with GSC-668 (Hodgson et al., 1984, Table 2; Blake, 1984).

Nunavut, Baffin region

Axel Heiberg Island

GSC-5369. White Glacier

modern
$\delta^{13}C$ = -28.8‰

The wood (*Salix arctica*, identified by C. Bégin) was enclosed in glacier ice. Sample 91-PIA-126 was collected by M. Parent on July 18, 1991, from the surface of White Glacier, near the center of the snout, Expedition Fiord area, Axel Heiberg Island (*see* Fig. 8b), Baffin region, Nunavut (79°25.8′N, 90°37.2′W), at an elevation of about 150 m. The sample was submitted by M. Parent.

The sample (15 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.3 g) yielded 7.69 L of CO_2 gas. The age estimate is based on two counts for 2050 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 28.375 ± 0.192, 2.305 ± 0.035, and 28.206 ± 0.135 cpm, respectively.

Baffin Island

Morris Island series

A series of marine mollusc shell samples from the southeastern shore of an unnamed bay west of Morris Island, south of 'Osborn Bay' (unofficial name), eastern Loks Land, on southern Baffin Island, Baffin region, Nunavut (62°27′N, 64°25′W), at an elevation of 19 m, was collected by D. Kaufman and G.H. Miller on August 7, 1989. The samples were submitted by G.H. Miller.

GSC-5340. Morris Island (I)

normalized age: 10 400 ± 210
corrected age: 9980 ± 210
$\delta^{13}C$ = +2.8‰
uncorrected age: 9940 ± 210

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Figure 8a. *Radiocarbon-dated sites in the Arctic Archipelago, Nunavut, Baffin Island*

The marine mollusc shell (a single valve of *Mya truncata*, identified by D. Kaufman), sample AAL-5930C, M 89-BS21 (6.5 g dry weight), from a surface collection on frost boils in glacial marine sediments, was treated with an acid leach to remove the outer 10% of the sample. The treated sample (6.3 g) yielded 1.37 L of CO_2 gas. The age estimate is based on one count for 3930 minutes in the 2 L counter with a mixing ratio of 3.27. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.303 ± 0.128, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

GSC-5328. Morris Island (II)

normalized age:	10 800 ± 140
corrected age:	10 400 ± 140
$\delta^{13}C$ =	+2.1‰
uncorrected age:	10 400 ± 140

The marine mollusc shell (a single valve of *Mya truncata*, identified by D. Kaufman), sample AAL-5930E, M 89-BS21 (15.6 g dry weight), from a surface collection on frost boils in glacial marine sediments, was treated with an acid leach to remove the outer 10% of the sample. The treated sample (14.8 g) yielded 3.23 L of CO_2 gas. The age estimate is based on one count for 3960 minutes in the 2 L counter with a mixing ratio of 1.37. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.104 ± 0.067, 1.261 ± 0.033, and 18.546 ± 0.156 cpm, respectively.

Comment (D. Kaufman and G. Miller): These two dates, each on a whole, well preserved, robust, single valve, are from frost boils near the top of a small bouldery terrace below the marine limit. The shells were angular, abundant, and unabraded. The lack of a proximal sediment source indicates the sediments are ice-proximal. Another sample from this collection dated 10 470 ± 160 (marine-reservoir corrected age on GX-15278; Kaufman and Williams, 1992). The dates indicate that outer Frobisher Bay was ice-free about 10.2 ka. Nearby dates on shells in till above the marine limit indicate that Loks Land was subsequently overrun by northward-flowing Labradorean ice during the Gold Cove advance (ca. 9.9 to 9.6 ka; *see* Miller and Kaufman, 1990; Kaufman et al., 1993). The shells from this collection might have been reworked from nearby Gold Cove till. More likely, the shells are in sediment that was overrun during the advance (cf. Miller and Kaufman, 1990). Thus, we believe they provide closely limiting maximum ages for the onset of the Gold Cove advance and are consistent with other dates from the same region.

GSC-5299. Beare Sound

normalized age:	9950 ± 320
corrected age:	9550 ± 320
$\delta^{13}C$ =	+1.9‰
uncorrected age:	9520 ± 320

The marine mollusc shell (a single fragment of *Mya truncata*, identified by D. Kaufman) was enclosed in sandy silt. Sample DK 91-34 was collected by D. Kaufman and W.F. Manley on August 9, 1991, from small cove on the south side of Beare Sound, where the channel projects southeastward into western Loks Land, on southern Baffin Island, Baffin region, Nunavut (62°30′N, 64°50′W), at an elevation of 36 m. The sample was submitted by G.H. Miller.

The sample (8.5 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (7.3 g) yielded 1.35 L of CO_2 gas. The age estimate is based on one count for 3570 minutes in the 2 L counter with a mixing ratio of 3.33. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.624 ± 0.218, 1.188 ± 0.059, and 18.396 ± 0.155 cpm, respectively.

Comment (D. Kaufman, G. Miller, and W.F. Manley): This date, on a single, robust, angular hinge fragment, is one of seven dates on molluscs collected at this site from frost boils in silty carbonate-rich drift below the marine limit. The others are 40 500 ± 2100 (AA-7557), >38 900 (AA-7558), 11 235 ± 90 (AA-7559), 11 140 ± 180 (AA-6300), 10 625 ± 85 (AA-8389), and 10 110 ± 75 (AA-8388) (note: these dates are marine-reservoir-corrected ages; *see* Kaufman and Williams, 1992, for details). The available dates define four distinct ages: >38.5 ka, 11.2 to 11.1 ka, 10.6 to 10.1 ka, and 9.5 ka. The 11 ka shells date an interval when outer Frobisher Bay was, at least in part, open to the sea and provide an age for ice-proximal sedimentation on western Loks Land. The 11 ka dates provide important evidence for a pre-Gold Cove advance of north-flowing ice onto southwestern Baffin Island (the Beare Sound advance of Kaufman et al., 1992). We interpret the deposit as a pocket of ice-proximal glacial-marine sediment that, because of its protected location at the foot of a prominent lee-side escarpment, escaped erosion by ice of the Gold Cove advance. Marine-limit indicators are anomalously high near the site (46 m, or about 10 m higher than the regional marine limit), and well preserved striae are oriented

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N30°W, more westerly than the regional pattern related to the Gold Cove advance. This evidence supports the idea that the site contains primary pre-Gold Cove deposits. The nonfinite shells must have been reworked into the younger deposits, whereas the younger shells were deposited in a thin mantle of debris prior to and after the Gold Cove advance.

GSC-5320. Gabriel Island

normalized age:	9650 ± 200
corrected age:	9250 ± 200
$\delta^{13}C$ =	+2.0‰
uncorrected age:	9220 ± 200

The marine mollusc shells (three valves of *Mya truncata*, identified by D. Kaufman) were enclosed in glacial marine sediments. Sample DK 91-24B was collected by D. Kaufman and M. Duvall on August 18, 1991, from the eastern shore of a large embayment near the southern end of Gabriel Island, central Frobisher Bay, southern Baffin Island, Baffin region, Nunavut (62°47′N, 66°25′W), at an elevation of 5 m. The sample was submitted by G.H. Miller.

The sample (14.1 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (11.7 g) yielded 2.31 L of CO_2 gas. The age estimate is based on two counts for 3145 minutes in the 2 L counter with a mixing ratio of 1.91. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.837 ± 0.136, 1.188 ± 0.059, and 18.396 ± 0.155 cpm, respectively.

Comment (D. Kaufman, G. Miller, and W.F. Manley): This date, on three pristine, paired valves collected in situ from a 15 m high beach cliff containing marine and glacial marine sediments, provides a minimum age for local deglaciation. This date overlaps, at two-sigma, a date on a paired valve from the same collection (AA-7896, marine-reservoir corrected age of 9530 ± 70; Kaufman and Williams, 1992). The dates are consistent with deposition shortly after the retreat of the last northward advance of Labradorean ice across outer Frobisher Bay, the Gold Cove advance (ca. 9.9 to 9.6 ka; Kaufman et al., 1993).

GSC-5903. Porter Inlet

normalized age:	7480 ± 120
corrected age:	7080 ± 120
$\delta^{13}C$ =	+1.05‰
uncorrected age:	7060 ± 120

The marine mollusc shells (*Mya truncata*, identified by W.F. Manley) were enclosed in sandy mud. Sample WM 94-05B was collected by W.F. Manley on July 24, 1994, from close to a large lake, 1.2 km northwest of the northern tip of Jenvey Island, at the head of a small bay in northwestern Porter Inlet, Frobisher Bay, southern Baffin Island, Baffin region, Nunavut (63°36.6′N, 68°10.4′W), at an elevation of 1 m. The sample was submitted by W.F. Manley.

The sample (8.9 g dry weight) was treated with an acid leach to remove the outer 5%. The treated sample (8.6 g) yielded 1.98 L of CO_2 gas. The age estimate is based on one count for 3850 minutes in the 2 L counter with a mixing ratio of 2.22. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.583 ± 0.095, 1.233 ± 0.025, and 18.272 ± 0.104 cpm, respectively.

Comment (W.F. Manley): This date was on several fragments and unpaired valves from at least six molluscs, excavated from the face of a wave-cut exposure in an ice-contact delta. The shells were taken from thin beds of laminated sandy mud within the lower portion of horizontally stratified sands, underlain by mostly massive mud. The sampled beds are interpreted as ice-proximal glaciomarine sediment, deposited when thin ice lay on the proximal side of the ice-contact delta, about 200 m to the north, at the southern edge of 'Easy Lake' (unofficial name) (*see* Squires, 1984). The date provides a minimum age for the nearby marine limit (96 m). It also establishes a surprisingly young age for the existence of thin, locally channeled ice close to the outermost Frobisher Bay Moraine (*see* Manley and Moore, 1995; Manley, 1995b).

GSC-5895. Eggleston Bay

normalized age:	9260 ± 110
corrected age:	8860 ± 110
$\delta^{13}C$ =	+0.69‰
uncorrected age:	8850 ± 110

The marine mollusc shells (*Hiatella arctica*, identified by W.F. Manley) were from a surface collection on frost boils of calcareous, olive-grey silty clay. Sample WM 94-33 was collected by W.F. Manley on October 8, 1994, from 50 m west of a large lake, 1.2 km north-northwest of the head of Eggleston Bay, Frobisher Bay, southern Baffin Island, Baffin region, Nunavut (63°13.2′N, 68°13.9′W), at an elevation of 66 m. The sample was submitted by W.F. Manley.

The sample (15.7 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (12.6 g) yielded 2.92 L of CO_2 gas. The age estimate is based on one count for 3860 minutes in the 2 L counter with a mixing ratio of 1.51. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.097 ± 0.068, 1.206 ± 0.026, and 18.348 ± 0.107 cpm, respectively.

Comment (W.F. Manley): This date was on 20 partial or complete, unpaired, well preserved valves collected from frost boils of calcareous drift, interpreted as glaciomarine sediment, below the local marine limit (129 m a.h.t.). The shells were leached with HCl to remove the outer 5% of the material prior to submittal (not recommended by the GSC laboratory). The date provides a minimum age for deglaciation after southeast-flowing ice stood at a large ice-contact delta in Eggleston Bay, about 1 km south of the sample site. The date also constrains the

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timing of glaciomarine deposition relating to a marine-based ice margin near Cape Rammelsberg or farther northwest in the head of Frobisher Bay. Together with other new dates (Manley and Moore, 1995; Manley, 1995b), this date indicates that ice from the Foxe/Amadjuak Dome lay at the outermost Frobisher Bay Moraine during the earliest Cockburn Substage (e.g. about 8.0 ka), centuries earlier than previously believed.

GSC-5526. Meta Incognita Peninsula

normalized age:	8090 ± 90
corrected age:	7690 ± 90
$\delta^{13}C$ =	+1.40‰
uncorrected age:	7670 ± 90

The marine shells (*Mya truncata* and *Hiatella arctica*, identified by G.H. Miller), sample WM 92-37B, were collected by W.F. Manley on August 2, 1992, 6.7 km east-southeast of Balcom Inlet, Meta Incognita Peninsula, southern Baffin Island, Baffin region, Nunavut (62°17.7′N, 68°35.5′W), at an elevation of 12 m. The sample was submitted by W.F. Manley.

The sample (19.7 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (17.7 g) yielded 4.01 L of CO_2 gas. The age estimate is based on one count for 3910 minutes in the 2 L counter with a mixing ratio of 1.10. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.053 ± 0.056, 1.213 ± 0.025, and 18.316 ± 0.104 cpm, respectively.

Comment (W.F. Manley): This date, one of the oldest postglacial dates from the southern coast of Baffin Island, helps to constrain the timing of deglaciation along the north-central Hudson Strait coast. The date also establishes a minimum elevation for sea level (≥12 m) at 7.7 ka. The date lies in the period of 8 to 7 ka as expected from consideration of other dates on coastal deglaciation (Blake, 1966; Clark, 1985). This date could have been as young as about 6 ka if the molluscs had lived in shallow water (assuming a postglacial sea-level fall similar to that of Lake Harbour). Instead, the molluscs apparently lived in water depths of about 20 to 30 m, and more closely constrain the timing of deglaciation than expected on elevation alone. The date also affirms that a pulse of glaciomarine sedimentation coincided with or closely followed coastal deglaciation (Manley, 1993, 1995a).

GSC-5688. 'Anachauqmik'

normalized age:	7780 ± 200
corrected age:	7380 ± 200
$\delta^{13}C$ =	+1.63‰
uncorrected age:	7350 ± 200

The marine shell (a single valve of *Hiatella arctica*, identified by W.F. Manley) was enclosed in glaciomarine silty clay. Sample WM 93-17 was collected by W.F. Manley on July 13, 1993, from Anachauqmik (unofficial name), 1.9 km northeast of the mouth of Bruce Harbour and 13 km southwest of Lake Harbour, Meta Incognita Peninsula, southern Baffin Island, Baffin region, Nunavut (62°46.41′N, 70°06.06′W), at an elevation of 39 m. The sample was submitted by W.F. Manley.

The sample (4.0 g dry weight) had no treatment and yielded 0.92 L of CO_2 gas. The age estimate is based on one count for 3860 minutes in the 2 L counter with a mixing ratio of 4.84. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.382 ± 0.175, 1.217 ± 0.025, and 18.431 ± 0.104 cpm, respectively.

Comment (W.F. Manley): This date was on a robust, unpaired, well preserved valve found on frost boils of grey, silty, calcareous drift, interpreted as glaciomarine sediment, below the marine limit (98 m). Like many dates now available for the Lake Harbour region (Manley, 1993, 1995a), this date helps define Holocene emergence and establishes a minimum age for the marine limit and landward retreat of a south-flowing ice divide on Meta Incognita Peninsula.

GSC-5699. Bosanquet Harbour

normalized age:	8110 ± 190
corrected age:	7710 ± 190
$\delta^{13}C$ =	+2.22‰
uncorrected age:	7680 ± 190

The marine mollusc shells (two valves of *Hiatella arctica* and *Mya truncata*, identified by W.F. Manley) were enclosed in glaciomarine silty clay. Sample WM 93-45 was collected by W.F. Manley on July 25, 1993, 2.2 km south of the head of Bosanquet Harbour, northeast Big Island, 35 km southwest of Lake Harbour, Meta Incognita Peninsula, southern Baffin Island, Baffin region, Nunavut (62°37.81′N, 70°22.44′W), at an elevation of 49 m. The sample was submitted by W.F. Manley.

The sample (5.4 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (5.0 g) yielded 1.12 L of CO_2 gas. The age estimate is based on one count for 3890 minutes in the 2 L counter with a mixing ratio of 3.91. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.074 ± 0.154, 1.199 ± 0.028, and 18.393 ± 0.105 cpm, respectively.

Comment (W.F. Manley): This date was on two robust, unpaired, well preserved valves from frost boils of grey, silty, calcareous drift below the marine limit (98 m), interpreted as glaciomarine sediment. Like a nearby dated collection (GSC-5677) and several other dates from Big Island (Manley et al., 1994; Manley, 1995a), the date provides a minimum age for the deglaciation of north-central Hudson Strait and establishment of the marine limit about 8.2 ka, with glaciomarine deposition continuing until about 7.0 ka. Given the nearby evidence for southward to southwestward flow, the date also constrains ice-marginal retreat from an ice cap on central Meta Incognita Peninsula. The date also helps define a relative sea-level curve for the Lake Harbour region that describes an exponentially decaying emergence during the Holocene (Clark, 1985; Manley, 1995a).

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GSC-5677. 'Bosanquet-Ashe Valley'

normalized age:	7940 ± 130
corrected age:	7540 ± 130
$\delta^{13}C$ =	+3.07‰
uncorrected age:	7490 ± 130

The marine shell (a single valve of *Mya truncata*, identified by W.F. Manley) was enclosed in glaciomarine silty clay. Sample WM 93-35 was collected by W.F. Manley on July 23, 1993, from the Bosanquet-Ashe Valley (unoffical name), 7.0 km west-southwest of the head of Bosanquet Harbour, east-central Big Island, 40 km southwest of Lake Harbour, Meta Incognita Peninsula, southern Baffin Island, Baffin region, Nunavut (62°37.17′N, 70°29.29′W), at an elevation of 45 m. The sample was submitted by W.F. Manley.

The sample (9.1 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (8.7 g) yielded 1.92 L of CO_2 gas. The age estimate is based on one count for 3370 minutes in the 2 L counter with a mixing ratio of 2.27. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.258 ± 0.099, 1.217 ± 0.025, and 18.431 ± 0.104 cpm, respectively.

Comment (W.F. Manley): This date was on an unpaired, robust, well preserved valve collected from frost boils of grey, silty, calcareous drift below the marine limit (95 m), interpreted as glaciomarine sediments. Like a nearby dated collection (GSC-5699) and several other dates from Big Island (Manley et al., 1994; Manley, 1995a), the date provides a minimum age for deglaciation of north-central Hudson Strait and the establishment of a marine limit about 8.2 ka, with glaciomarine deposition continuing until about 7.0 ka. Given the nearby evidence for southward to southwestward flow, the date constrains ice-marginal retreat from an ice cap on central Meta Incognita Peninsula. The date also helps define a relative sea-level curve for the Lake Harbour region that describes exponentially decaying emergence during the Holocene (Clark, 1985; Manley, 1995a).

GSC-5354. Bylot Island

normalized age:	130 ± 50
$\delta^{13}C$ =	-25.0‰
uncorrected age:	130 ± 50

The organic sediment, a moss-clay mixture, was enclosed in ice. Sample SCA-91-04A was collected by C. Zdanowicz on July 13, 1991, from the western frontal margin of Glacier B-7, Bylot Island, 55 km northwest of Pond Inlet, Baffin Island, Baffin region, Nunavut (72°01′07″N, 79°10′36″W), at an elevation of 420 m. The sample was submitted by W.W. Shilts.

The sample (850.8 g wet weight) was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (15.5 g) yielded 6.89 L of CO_2 gas. The age estimate is based on two counts for 2095 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 27.974 ± 0.124, 2.234 ± 0.029, and 28.421 ± 0.132 cpm, respectively.

Comment (W.W. Shilts): This peat lay within sediment-rich ice strata at the base of the frontal ice cliff of Glacier B-7. It was thought to have been overridden by the glacier, which is now as far advanced as it has been in the past 600(+) years. The young age is consistent with the observation of nearly lichen-free boulders at the outer margin of nearby Aktineq Glacier, which has recently retreated from its farthest advanced position.

GSC-5311. Whyte Inlet (I)

normalized age:	4230 ± 90
corrected age:	3830 ± 90
$\delta^{13}C$ =	+2.3‰
uncorrected age:	3790 ± 90

The marine shells (*Mya truncata*, identified by J. Hooper) were enclosed in poorly stratified sand and mud, 2.5 m below the top of the section. Sample 91-DCA-472 was collected by J. Hooper on August 13, 1991, 1 km east of the river mouth at the head of Whyte Inlet, northwest Baffin Island, Baffin region, Nunavut (70°07′N, 84°46′W), at an elevation of 10.5 m. The sample was submitted by A. Dyke.

The sample (24.4 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (21.2 g) yielded 4.42 L of CO_2 gas. The age estimate is based on two counts for 2190 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.567 ± 0.084, 1.261 ± 0.033, and 18.546 ± 0.156 cpm, respectively.

Comment (J. Hooper): The sample is older than expected from its elevation on the basis of the identical date for shells collected at 24 m (GSC-5374, McNeely and Atkinson, 1996) in the same area. The elevation is based on two altimeter readings with seven minutes between sample site readings and a reading at sea level. The date is one of nine used to construct an emergence curve for Autridge Bay and Whyte Inlet.

GSC-5316. Whyte Inlet (II)

normalized age:	2860 ± 100
corrected age:	2460 ± 100
$\delta^{13}C$=	+2.1‰
uncorrected age:	2420 ± 100

The marine shells (*Mya truncata*, identified by J. Hooper) were enclosed in massive sandy mud with dropstones underlying a gravel layer of an erosional terrace. Sample 91-DCA-471 was collected by J. Hooper on August 13, 1991, from the head of Whyte Inlet, northwest Baffin Island, Baffin region, Nunavut (70°7′N, 84°48′W), at an elevation of 4.0 m. The sample was submitted by A. Dyke.

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The sample (37.0 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (31.6 g) yielded 5.29 L of CO_2 gas. The age estimate is based on two counts for 2230 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 13.713 ± 0.121, 1.261 ± 0.033, and 18.546 ± 0.156 cpm, respectively.

Comment (J. Hooper): The collection is from a 30 cm thick horizon, 1.2 m below the top of the section (at 5.2 m a.s.l.). The uppermost unit in this section is a 70 cm thick gravel layer. The gravel cap suggests an erosional origin for the level terrace surface at the top of the section. The elevation of the sample site (above the high-tide line at the base of the section) was measured with a tape measure. The sample is older than expected from its elevation indicating that the shells grew in some depth of water. The date is the lowest and youngest of nine used to construct an emergence curve for Autridge Bay and Whyte Inlet.

GSC-5233. Cape York

uncorrected age: 9260 ± 130

The marine shells (*Hiatella arctica*, identified by A.S. Dyke) were on the surface of pebbly silt. Sample CD 49/63 was collected by B.G. Craig on July 16, 1963, 6.2 km southeast of Cape York, Brodeur Peninsula, Baffin Island, Baffin region, Nunavut (73°46.5′N, 86°55′W), at an elevation of 41 m. The sample was submitted by A.S. Dyke.

The sample (12.4 g dry weight) was treated with an acid leach to remove the outer 10%. The treated sample (11.3 g) yielded 2.43 L of CO_2 gas. The age estimate is based on one count for 3970 minutes in the 2 L counter with a mixing ratio of 1.84. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 5.809 ± 0.079, 1.110 ± 0.028, and 18.388 ± 0.133 cpm, respectively.

Comment (A.S. Dyke): The shells at this site were collected over a vertical range of 7 m. They consisted mostly of fragments, but *Portlandia arctica* shells were articulated. *Mya truncata* and *Balanus crenatus* also occur in this sample, but only *Hiatella arctica* fragments were used for dating. The shells were collected from the surface of a dissected glaciomarine deposit in the outer part of the large valley at Cape York and on the eastern side of the river. The marine limit further up-valley is at 62 m a.s.l. and dated at 9500 ± 110 (GSC-4879, McNeely and Jorgensen, 1993).

Bathurst Island

GSC-5342. Rapid Point

normalized age: 9120 ± 120
corrected age: 8720 ± 120
$\delta^{13}C$ = +1.3‰
uncorrected age: 8700 ± 120

Figure 8b. *Radiocarbon-dated sites in the Arctic Archipelago, Nunavut, Queen Elizabeth Islands.*

The marine shells (*Mya truncata*, identified by W. Blake, Jr.) were in a stream bed. Sample 91-BS-6.8-2 was collected by W. Blake, Jr. on August 6, 1991, 11 km west-southwest of Rapid Point, eastern Bathurst Island, Baffin region, Nunavut (75°50.1′N, 97°54.9′W), at an elevation of 71 m. The sample was submitted by W. Blake, Jr.

The sample (27.9 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (23.1 g) yielded 5.07 L of CO_2 gas. The age estimate is based on two counts for 1980 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 6.188 ± 0.072, 1.288 ± 0.028, and 18.276 ± 0.111 cpm, respectively.

Comment (W. Blake, Jr.): This age determination fills in a gap in the coverage around the coasts of Bathurst Island.

Ellesmere Island

GSC-5280. Hot Weather Creek

normalized age: 1910 ± 60
$\delta^{13}C$ = -27.9‰
uncorrected age: 1960 ± 60

The peat was enclosed in sand. Sample FP-23.07.90-01 was collected by C. Bégin and Y. Michaud on July 23, 1990, 5 km north of the Hot Weather Creek campsite, Fosheim Peninsula, Ellesmere Island, Baffin region, Nunavut (79°59′N, 84°08′W), at an elevation of 122 m. The sample was submitted by C. Bégin.

The sample (121.8 g dry weight) was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (34.1 g) yielded 8.12 L of CO_2 gas. The age estimate is based on two counts for 2100 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the

sample (net) and for monthly backgrounds and standards (net) were 22.216 ± 0.130, 2.287 ± 0.039, and 28.354 ± 0.135 cpm, respectively.

'Big Slide Creek' series

A series of wood samples from 'Big Slide Creek' (unofficial name) 44 km southeast of Eureka, Ellesmere Island, Baffin region, Nunavut (79°43'N, 84°25'W), at an elevation of 155 m, was collected by A.G. Lewkowicz on August 5, 1990. The samples were submitted by A.G. Lewkowicz.

GSC-5261. 'Big Slide Creek' (I)

normalized age:	330 ± 100
$\delta^{13}C$ =	-30.2‰
uncorrected age:	410 ± 100

The wood, sample 1990-15/16 (2.0 g dry weight; *Salix*, identified by H. Jetté (unpublished GSC Wood Report nos. 91-47, 91-61)), enclosed in a clayey sand colluvium, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (1.5 g) yielded 1.56 L of CO_2 gas. The age estimate is based on two counts for 2400 minutes in the 2 L counter with a mixing ratio of 2.87. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.218 ± 0.176, 1.312 ± 0.025, and 18.119 ± 0.128 cpm, respectively.

Comment (A.G. Lewkowicz): The willow root samples were collected from colluvium within permafrost near the top of a 40 m long section. Together with GSC-5227, this date gives an indication of surface aggradation rates due to colluviation ranging from 4 to 25 mm/a (range assuming ± 1 standard error) with a mean of 7 mm/a for the period 540 ± 50 to 330 ± 100 BP. This surface aggradation is attributed to a combination of slopewash, solifluction, and active-layer detachment processes.

GSC-5227. 'Big Slide Creek' (II)

normalized age:	540 ± 50
$\delta^{13}C$ =	-28.0‰
uncorrected age:	590 ± 50

The wood, sample 1990-9 (9.2 g dry weight; *Salix*, identified by H. Jetté (unpublished GSC Wood Report No. 91-34)), enclosed in a well developed root horizon in silty sand of a colluvium sequence, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (7.5 g) yielded 6.80 L of CO_2 gas. The age estimate is based on two counts for 2000 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 26.325 ± 0.123, 2.055 ± 0.028, and 28.334 ± 0.123 cpm, respectively.

Comment (A.G. Lewkowicz): The sample was collected from a well developed root horizon within a colluvial sequence exposed at a 40 m long section. This date gives a minimum age for the onset of colluviation. Together with GSC-5261 it gives an indication of surface-aggradation rates due to colluviation ranging from 4 to 25 mm/a (range assuming ±1 standard error) with a mean of 7 mm/a for the period 540 ± 50 to 330 ± 100 BP (corrected ages). This surface aggradation is attributed to a combination of slopewash, solifluction, and active-layer detachment processes. This sample also provides a minimum age for one epigenetic wedge that has a regrowth spike at a level beneath the sample, and a maximum age for a second epigenetic wedge that cross-cuts a segregated ice layer 0.5 m above the sample.

GSC-5229. 'Big Slide Creek' (III)

normalized age:	6460 ± 70
$\delta^{13}C$ =	-29.4‰
uncorrected age:	6530 ± 70

The upper peat, sample 1990-2 (74.2 g dry weight), enclosed in peat underlying colluvium, was treated with cold base, hot acid (slightly calcareous), and distilled water rinses. The treated sample (13.0 g) yielded 8.15 L of CO_2 gas. The age estimate is based on one count for 3320 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.565 ± 0.072, 2.055 ± 0.028, and 28.334 ± 0.123 cpm, respectively.

Comment (A.G. Lewkowicz): The sample was collected at the top of a local peat deposit exposed beneath colluvial sediments. This date provides a minimum age for the termination of peat accumulation and the maximum age for the start of colluviation in this part of the section. Together with GSC-5237, it gives a mean rate of peat accumulation of about 1 mm/a for the period 7.7 ka to 6.5 ka BP (corrected ages). It also provides a minimum age for a syngenetic ice wedge that penetrates the peat and extends as a vein into the overlying colluvium.

GSC-5237. 'Big Slide Creek' (IV)

normalized age:	7650 ± 120
$\delta^{13}C$ =	-28.8‰
uncorrected age:	7710 ± 120

The basal peat, sample 1990-1 (60.2 g dry weight), was treated with cold base, hot acid (noncalcareous), and distilled water rinses. The treated sample (7.8 g) yielded 5.86 L of CO_2 gas. The age estimate is based on one count for 2400 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 7.001 ± 0.064, 1.065 ± 0.026, and 18.277 ± 0.188 cpm, respectively.

Comment (A.G. Lewkowicz): The sample was collected beneath a thermo-erosional niche near the base of a local peat deposit at the northern end of a 40 m long exposure. This date is the minimum for the start of peat accumulation at the site.

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Together with GSC-5229, this sample gives a mean rate of peat accumulation of about 1 mm/a for the period 7.7 ka to 6.5 ka BP.

Victoria Island

GSC-5222. Natkusiak Peninsula

normalized age:	7580 ± 70
corrected age:	7180 ± 70
$\delta^{13}C$ =	+3.1‰
uncorrected age:	7120 ± 70

The marine shells (*Hiatella arctica*, identified by D.A. Hodgson) were enclosed in a silt lens in a granule to boulder bed. Sample HCA 82-6-7-6 was collected by J. Bednarski and D.A. Hodgson on July 6, 1982, from northeast Natkusiak Peninsula, Victoria Island (*see* Fig. 7), Baffin region, Nunavut (72°56′N, 109°50′W), at an elevation of 10 m. The sample was submitted by D.A. Hodgson.

The sample (42.3 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (32.4 g) yielded 7.21 L of CO_2 gas. The age estimate is based on one count for 3770 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 11.671 ± 0.066, 2.055 ± 0.028, and 28.334 ± 0.123 cpm, respectively.

Comment (D.A. Hodgson): The pocket of shells is from the topset beds in a marine delta related to a sea level higher than 16 m and lower than 20 m.

INTERNATIONAL

Brazil

GSC-5246. Sai-Guacu River

normalized age:	3480 ± 60
corrected age:	3080 ± 60
$\delta^{13}C$ =	-0.5‰
uncorrected age:	3080 ± 60

The marine mollusc shells (*Anomalocardia brasiliana*, identified by T.M. Absher) were enclosed in clayey sand. Sample 07.10.89.02.C was collected by R.J. Angulo on October 7, 1989, from between Sai-Guacu River and State Road 412, 10 km southwest from the town of Guaratuba, Municipio de Guaratuba (district), Estado do Paraná, Brazil (25°57′13″S, 48°38′41″W), at an elevation of 1.0 m. The sample was submitted by R.J. Angulo.

The sample (45.1 g dry weight) was treated with an acid leach to remove the outer 20%. The treated sample (35.3 g) yielded 8.06 L of CO_2 gas. The age estimate is based on two counts for 2540 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.191 ± 0.098, 2.186 ± 0.033, and 28.173 ± 0.146 cpm, respectively.

Comment (R.J. Angulo): This shell date was used as a paleo sea-level indicator; 3.5 ka BP sea level was more than 0.60 m higher than today.

GSC-4678. Rasa Island

normalized age:	5380 ± 60
$\delta^{13}C$ =	-26.3‰
uncorrected age:	5400 ± 60

The wood (unidentifiable according to H. Jetté (unpublished GSC Wood Report No. 91-52)) was enclosed in sand. Sample 22.04.01.3.B was collected by R.J. Angulo on April 22, 1991, from Rasa Island, 9 km southwest of Gjuaroqueçaba, Municipio de Guaroqueçaba (district), Estado do Paraná, Brazil (25°19′44″S, 48°24′11″W), at an elevation of 1 m. The sample was submitted by R.J. Angulo.

The sample (20.9 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (9.0 g) yielded 8.68 L of CO_2 gas. The age estimate is based on one count for 3375 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.432 ± 0.080, 2.196 ± 0.038, and 28.279 ± 0.131 cpm, respectively.

Comment (R.J. Angulo): This date indicates that at 5.4 ka BP sea level was 1.90 ± 0.50 m higher than today.

GSC-5243. Picarras

normalized age:	6410 ± 80
$\delta^{13}C$ =	-30.5‰
uncorrected age:	6500 ± 80

The wood (Clusiaceae family, identified by H. Jetté (unpublished GSC Wood Report No. 91-39)) was enclosed in an upper shoreface of crossbedded sand. Sample 24.09.04 was collected by R.J. Angulo on March 1, 1991, from Picarras, 2 km west of the town of Guaratuba, Municipio de Guaratuba (district), Estado do Paraná, Brazil (25°52′26″S, 48°36′01″W), at an elevation of 0 m. The sample was submitted by R.J. Angulo.

The sample (12.9 g dry weight) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (7.4 g) yielded 7.62 L of CO_2 gas. The age estimate is based on two counts for 1900 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 12.617 ± 0.093, 2.055 ± 0.028, and 28.334 ± 0.123 cpm, respectively.

Comment (R.J. Angulo): This date was very useful in determining the age of the coastal sediments. Along with this, the age of the wood sample that occurs associated with *Ophiomorpha*, attributed to *Callichirus major*, was used as a paleo sea-level indicator. Therefore, at 6.1 ka BP sea level was 1.60 ± 0.50 m higher than today.

Conchas Headland series

A series of marine gastropod shell samples from Conchas Headland on Mel Island, 8 km northeast of Pontal do Sol, Municipio de Paranagua (district), Estado do Paraná, Brazil (25°32′17″S, 48°17′28″W), GSC-5251 at an elevation of 1.0 m and GSC-5255 at an elevation of 3 m, were collected by R.J. Angulo on April 26, 1990. The samples were submitted by R.J. Angulo.

GSC-5251. Conchas Headland (I)

normalized age:	790 ± 80
corrected age:	390 ± 80
$\delta^{13}C$ =	+0.2‰
uncorrected age:	380 ± 80

The marine gastropod shells, sample 26.04.90.01.A (50.0 g dry weight; *Petaloconchus (Macrophragma) varians*, identified by T.M. Absher), from a surface collection, were treated with an acid leach to remove the outer 5%. The treated sample (20.5 g) yielded 4.62 L of CO_2 gas. The age estimate is based on two counts for 2040 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 17.518 ± 0.100, 1.213 ± 0.021, and 18.379 ± 0.137 cpm, respectively.

GSC-5255. Conchas Headland (II)

normalized age:	3500 ± 60
corrected age:	3100 ± 60
$\delta^{13}C$ =	+1.26‰
uncorrected age:	3080 ± 60

The marine gastropod shells, sample 26.04.90.01.B (52.7 g dry weight; *Petaloconchus (Macrophragma) varians*, identified by T.M. Absher), from a surface collection, were treated with an acid leach to remove the outer 20% of the sample. The treated sample (35.8 g) yielded 6.41 L of CO_2 gas. The age estimate is based on two counts for 2550 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 19.214 ± 0.098, 2.186 ± 0.033, and 28.173 ± 0.146 cpm, respectively.

Comment (R.J. Angulo): The shell dates were used as paleo sea-level indicators; at 3500 ± 60 BP (GSC-5255), sea level was 2.90 ± 0.50 m higher than today; at 790 ± 80 BP (GSC-5251), sea level was 0.40 ± 0.50 m higher than today.

These age determinations were used in support of the Ph.D. thesis of Rodolfo J. Angulo, entitled "Geologia do Planicie Costeiro do Estado do Paraná" (Coastal plain geology of the State of Paraná).

The preceding five dates were contributed by the Geological Survey of Canada to the 'International Geological Correlation Programme: Project 274 on Coastal Evolution in the Quaternary' to help stimulate coastal research in developing countries. The ^{14}C dating pool was administered by Dr. J.F. Wehmiller, University of Delaware, United States of America.

New York State, United States of America

GSC-5277. Boyd Pond

normalized age:	11 900 ± 220
$\delta^{13}C$ =	-28.1‰
uncorrected age:	11 900 ± 220

The lake sediment, basal gyttja, sample AP-89-13 (895–900 cm), was collected by T.W. Anderson on September 20, 1989, from Boyd Pond, 23 km south-southeast of Canton, New York (Fig. 4), United States of America (44°23′25″N, 75°05′35″W), at an elevation of about 246 m. The sample was submitted by T.W. Anderson.

The sample (228.8 g wet weight) was treated with hot acid (very calcareous) and distilled water rinses. The base treatment was omitted. The treated sample (132.1 g) yielded 1.63 L of CO_2 gas. The age estimate is based on one count for 3560 minutes in the 2 L counter with a mixing ratio of 2.72. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.109 ± 0.103, 1.216 ± 0.026, and 18.122 ± 0.101 cpm, respectively.

GSC-5263. Clear Lake

normalized age:	12 000 ± 270
$\delta^{13}C$ =	-28.4‰
uncorrected age:	12 100 ± 270

The lake sediment, gyttja, sample AP-89-12 (572–576 cm), was collected by T.W. Anderson in September 1991 from Clear Lake, 21 km southeast of Canton, New York, United States of America (44°26′14″N, 75°1′15″W), at an elevation of 296 m. The sample was submitted by T.W. Anderson.

The sample (250.6 g wet weight) was treated with hot acid (moderately calcareous) and distilled water rinses. The base treatment was omitted. The treated sample (150.7 g) yielded 2.40 L of CO_2 gas. The age estimate is based on two counts for 1900 minutes in the 2 L counter with a mixing ratio of 1.86. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 4.183 ± 0.122, 1.224 ± 0.025, and 18.875 ± 0.273 cpm, respectively.

Portugal

Esmoriz series

A series of wood samples from the groyne area south of Esmoriz (Espinho), District of Aveiro, Portugal (41°N, 8°39′W), at an elevation of 0 m, was submitted by G. Soares de Carvalho to gain information on sea-level change in the Quaternary.

GSC-5379. Esmoriz (I)

normalized age:	28 100 ± 510
$\delta^{13}C$ =	-23.9‰
uncorrected age:	28 000 ± 510

The wood sample from 250 m south of the Praia de Esmoriz (Esmoriz Beach) groyne was collected by G. Soares de Carvalho on September 21, 1990. Sample ESP-7A.C (12.0 g dry weight; *Pinus sylvestris*, identified by H. Jetté (unpublished GSC Wood Report No. 92-15)), enclosed in beach sand, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.6 g) yielded 9.59 L of CO_2 gas. The age estimate is based on two counts for 2220 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.861 ± 0.052, 2.197 ± 0.037, and 28.267 ± 0.155 cpm, respectively.

GSC-5393. Esmoriz (II)

normalized age:	29 000 ± 510
$\delta^{13}C$ =	-27.6‰
uncorrected age:	29 100 ± 510

The wood sample from 250 m south of the Praia de Esmoriz groyne was collected by G. Soares de Carvalho on September 21, 1990. Sample ESP-7G M2 (21.1 g dry weight; *Pinus sylvestris*, identified by H. Jetté (unpublished GSC Wood Report No. 92-23)), enclosed in peat, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (8.3 g) yielded 9.39 L of CO_2 gas. The age estimate is based on one count for 2310 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.760 ± 0.046, 2.234 ± 0.029, and 28.421 ± 0.132 cpm, respectively.

GSC-5541. Esmoriz (III)

normalized age:	29 000 ± 690
$\delta^{13}C$ =	-26.1‰
uncorrected age:	29 000 ± 690

The wood sample from 500 m south of the Praia de Esmoriz groyne was collected by G. Soares de Carvallo on October 21, 1990. Sample ESP-7A2-M2 (22.50 g dry weight; *Pinus sylvestris*, identified by H. Jetté (unpublished GSC Wood Report No. 93-19)) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (7.9 g) yielded 9.3 L of CO_2 gas. The age estimate is based on two counts for 2025 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 0.766 ± 0.064, 2.176 ± 0.051, and 28.307 ± 0.186 cpm, respectively.

Comment (G. Soares de Carvallo): The sample was taken from a tree in a vertical position in the foreshore of a beach that was under strong erosion. The trunks are now covered by sand beaches or by a seawall built to protect the village from the sea.

Praia de Maceda series

A series of wood charcoal samples from the groyne area at Praia de Maceda (Maceda Beach), Ovar, District of Aveiro, Portugal (41°N, 8°38'W), at an elevation of 0 m, were collected by G. Soares de Carvalho to gain information on sea-level change in the Quaternary.

GSC-5417. Praia de Maceda (I)

normalized age:	23 100 ± 570
$\delta^{13}C$ =	-23.0‰
uncorrected age:	23 100 ± 570

The wood sample from 1500 m south of the Praia de Cortegaca (Cortegaca Beach) groyne was collected by G. Soares de Carvalho on October 19, 1991, from the Maceda Beach Formation. Sample ESP-17 M 1 (4.0 g dry weight; *Pinus sylvestris* type, identified by H. Jetté (unpublished GSC Wood Report No. 92-55)), enclosed in sand, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (2.8 g) yielded 1.99 L of CO_2 gas. The age estimate is based on one count for 3870 minutes in the 2 L counter with a mixing ratio of 2.19. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 1.018 ± 0.071, 1.246 ± 0.024, and 18.063 ± 0.123 cpm, respectively.

GSC-5540. Praia de Maceda (II)

	modern
$\delta^{13}C$ =	-25.6‰

The wood (root) sample from 300 m north of Praia de Maceda was collected by G. Soares de Carvallo on September 18, 1992. Sample ESP-25R.1 (2.7 g dry weight; unidentifiable according to H. Jetté (unpublished GSC Wood Report No. 93-17)), enclosed in silty sand, was treated with hot base, hot acid, and distilled water rinses (noncalcareous). The treated sample (2.4 g) yielded 2.2 L of CO_2 gas. The age estimate is based on one count for 1000 minutes in the 2 L counter with a mixing ratio of 2.04. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 21.251 ± 0.231, 1.216 ± 0.035, and 18.123 ± 0.108 cpm, respectively.

GSC-5557. Praia de Maceda (III)

	modern
$\delta^{13}C$ =	-24.4‰

The wood (roots?) from 400 m north of Praia de Maceda was collected by G. Soares de Carvallo on September 25, 1992. Sample ESP-25R.2 (26.0 g dry weight; too small to identify according to H. Jetté (unpublished GSC Wood Report No. 93-28)) was treated with hot base, hot acid, and distilled water

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rinses. The treated sample (7 g) yielded 6.6 L of CO_2 gas. The age estimate is based on one count for 1000 minutes in the 2 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 30.044 ± 0.178, 1.179 ± 0.020, and 18.355 ± 0.109 cpm, respectively.

GSC-5416. Praia de Maceda (IV)

normalized age:	14 300 ± 160
$\delta^{13}C$=	-24.6‰
uncorrected age:	14 300 ± 160

The wood charcoal sample from 1.0 km north of the Praia de Maceda groyne was collected by G. Soares de Carvalho on August 30, 1991. Sample ESP-15.1 C (10.6 g dry weight; *Pinus sylvestris*, identified by H. Jetté (unpublished GSC Wood Report No. 92-47)), enclosed in green silty sand, was treated with hot base, hot acid (noncalcareous), and distilled water rinse. The treated sample (6.4 g) yielded 3.14 L of CO_2 gas. The age estimate is based on one count for 5500 minutes in the 2 L counter with a mixing ratio of 1.41. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 3.083 ± 0.048, 1.209 ± 0.024, and 18.316 ± 0.145 cpm, respectively.

Comment (G. Soares de Carvallo): The dated sample was enclosed in a green silty sand at the top of an erosional cliff. The stratigraphic relationships were not clear, but the sample was lower in the profile than the paleosol where sample ESP-16.3C was taken.

Laboratory comment: An attempt to re-date sample ESP-15.1 C was made, but unfortunately not with the same material that was used for GSC-5416. The amount of gas produced was very small — smaller than what the laboratory would normally consider processing, i.e. the laboratory would have normally thrown the small amount of gas away. The mixing ratio for this preparation was 7.43. A mixing ratio of 4.0 is the maximum that the laboratory allows for a legitimate GSC age estimate.

Since the age was substantially younger (11.5 ka) than the original date (14.3 ka), unfortunately it does not verify the age estimate on the original material (ESP-15.1 C).

Praia de Cortegaca series

A series of wood and charcoal samples from a paleosol in the Cortegaca Beach Formation were collected from the groyne area on Praia de Cortegaca, Ovar, District of Aveiro, Portugal (41°N, 8°38'W). These samples were submitted by G. Soares de Carvallo to gain information on sea-level change in the Quaternary.

GSC-5512. Praia de Cortegaca (I)

normalized age:	1970 ± 110
$\delta^{13}C$ =	-25.2‰
uncorrected age:	1980 ± 110

The charcoal from 40 m south of the groyne near the Praia de Cortegaca campground was collected by G. Soares de Carvallo on September 18, 1992. Sample ESP-1-1OC (21.80 g dry weight; deciduous, identified by H. Jetté (unpublished GSC Wood Report No. 93-05)) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (8.7 g) yielded 1.7 L of CO_2 gas. The age estimate is based on two counts for 2100 minutes in the 2 L counter with a mixing ratio of 2.82. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 14.188 ± 0.168, 1.214 ± 0.024, and 18.146 ± 0.102 cpm, respectively.

GSC-5471. Praia de Cortegaca (II)

normalized age:	2540 ± 50
$\delta^{13}C$ =	-26.3‰
uncorrected age:	2560 ± 50

The wood charcoal from 100 m south of the groyne near the Praia de Cortegaca campground was collected by G. Soares de Carvalho on August 9, 1992. Sample ESP-2.3 m (22.0 g dry weight; *Pinus*?, identified by R.J. Mott (unpublished GSC Wood Report No. 93-36)) was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (16.4 g) yielded 11.97 L of CO_2 gas. The age estimate is based on one count for 3880 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 20.428 ± 0.081, 2.193 ± 0.027, and 28.110 ± 0.129 cpm, respectively.

GSC-5418. Praia de Cortegaca (III)

normalized age:	2660 ± 50
$\delta^{13}C$ =	-27.2‰
uncorrected age:	2700 ± 50

The wood charcoal from 500 m north of the settlement of Praia de Cortegaca was collected by G. Soares de Carvalho on October 19, 1991. Sample ESP-16.3C (16.2 g dry weight; unidentifiable according to H. Jetté (unpublished GSC Wood Report No. 92-48)), enclosed in green fine-grained sand, was treated with hot base, hot acid (noncalcareous), and distilled water rinses. The treated sample (10.8 g) yielded 8.24 L of CO_2 gas. The age estimate is based on one count for 3880 minutes in the 5 L counter with a mixing ratio of 1.00. The count rates for the sample (net) and for monthly backgrounds and standards (net) were 20.218 ± 0.080, 2.106 ± 0.025, and 28.293 ± 0.128 cpm, respectively.

General comment (G. Soares de Carvalho): *See* Granga and De Groot (1996) for a discussion of the regional context. These dates and wood identifications are very important for the Quaternary history of the region for the following reasons:

1. For the first time, *Pinus sylvestris* has been found in the coastal zone of Portugal, as fossil trees. *Pinus sylvestris* now occurs in Serra do Geres (northern Portugal) as relicts and persisted in the Serra da Estrela (central Portugal) up until a few decades ago.

2. These dates and taxon identifications provide very important information for the Quaternary history of the region by indicating that a cold climate prevailed in the coastal zone of Portugal into the early Holocene.

3. The pine forest is now buried in beach deposits below sea level. This information aids in understanding how neotectonic deformation and the strong coastal erosion of beaches and sea cliffs have caused coastal retreat in this sector of the coast of Portugal.

These 10 dates were contributed by the Geological Survey of Canada to the 'International Geological Correlation Programme: Project 274 on Coastal Evolution in the Quaternary' to help stimulate coastal research in developing countries. The ^{14}C dating pool was administered by Dr. J.F. Wehmiller, University of Delaware, United States of America.

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[1] HP- 'High pressure' (5L counter at four atmospheres)